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Multiple-Arch Diversion Dam at Three Miles Falls, Oregon

By H. D. Newell*

In December, 1913, the Secretary of the Interior authorized the extension of the Umatilla Project west of the Umatilla River. Construction was promptly begun on the main canal to divert water for the first unit of 10,000 acres. The diversion dam is on the Umatilla River adjacent to the line of the Oregon-Washington Railroad & Navigation Co., 186 miles east of Portland and about midway between the towns of Hermiston and Umatilla.

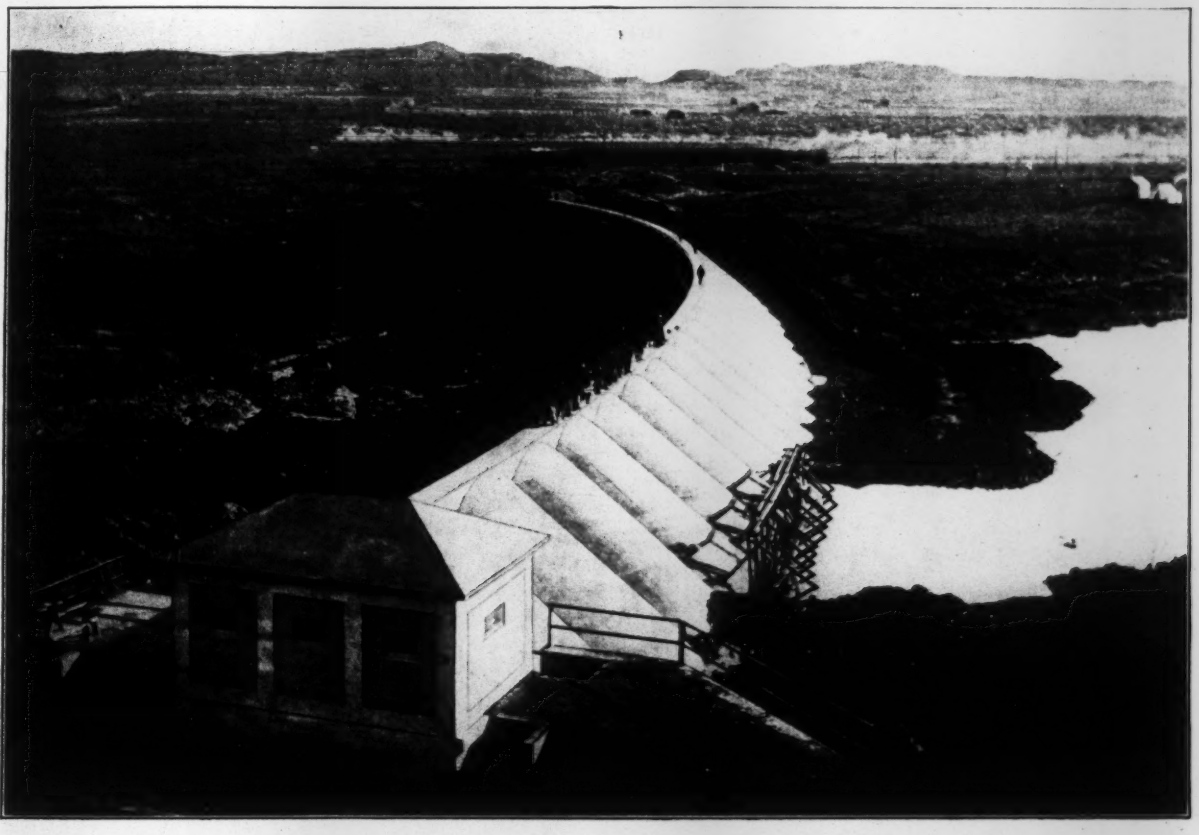

Fig. 1. Diversion Dam at Three Miles Falls, Oregon, on the Umatilla Project, U. S. Reclamation Service

The lower four miles of the Umatilla River is in a shallow basaltic gorge with exposed rock bottom and commonly low rock sidewalls. Investigations carried on at different times in 1911 and since disclosed a number of feasible diversion points. The west bank of the river rises abruptly about 50 ft. above the water level, so that the determination of the best diversion point was largely a question of balancing the lesser cost of a dam as one proceeded upstream against the increased cost of a canal in a difficult location. The most suitable place was finally determined to be immediately above a low fall locally known as Three Miles Falls, where the river drops about five feet. A bare ledge was exposed in the river bed both above and below the falls. Rock was also exposed on both banks for a few feet above the water surface. Two diamond-drill holes, one on each bank of the river, showed that the rock was of fair quality and sufficiently thick to support safely the comparatively low structure contemplated. A number of test pits on the east bank of the river disclosed inferior rock with only two or three feet of

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cover. For a short distance along the axis of the dam and for a considerable area above there was an exposed sheet of lava.

Studies for the dam were carried on at various times, and different types were considered, but it was decided that a multiple-arch concrete dam would best meet conditions. Work was started July 7, 1914, and was vigorously prosecuted until its completion, Nov. 28, 1914.

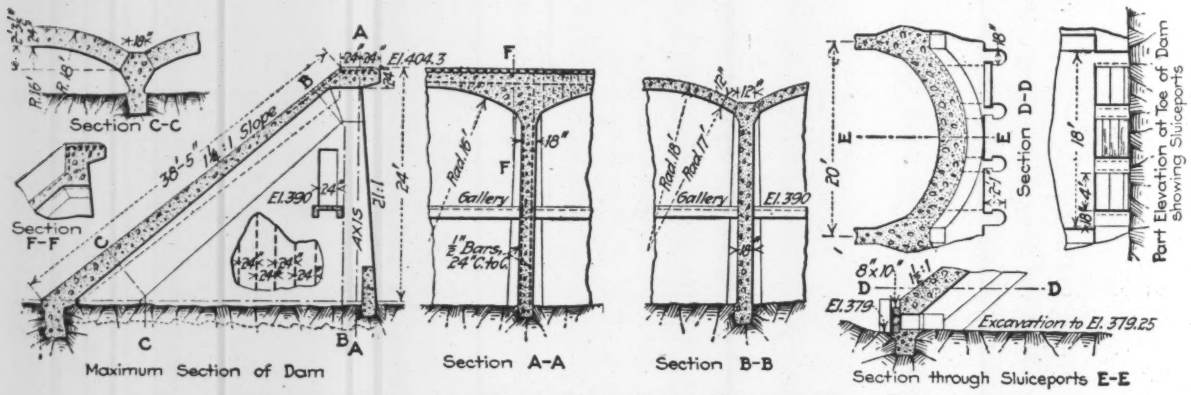


FIG. 2. DETAILS OF THREE MILES FALLS MULTIPLE-ARCH DAM

DESIGN OF DAM

The design finally adopted was for a multiple-arch dam of concrete, maximum height 24 ft. (Fig. 2). The axis is curved, having a radius of 1200 ft. The curved plan was chosen partly because of its pleasing appearance, but mainly because it seemed to best fit the rock contour and give the most favorable escape to the main channel for water passing over the crest. There are 40 arches springing between piers 20 ft. c. to c. These arches are 12 in. at the crest and increase in thickness downward at the rate of ½ in. for each vertical foot. The upstream face of the piers and arches has a slope of 1¼ to 1. The downstream face of the piers has a batter of 1 to 12. The piers are connected and stiffened by a concrete walk 36 in. wide. A training wall 1 ft. thick and about 4 ft. high connects all piers with the exception of those in the river channel. The arches rise from a cutoff wall about 6 ft. thick and from 6 to 10 ft. deep, extending into solid rock. Fig. 2 shows sections of the dam and clearly depicts important features.

The piers are 18 in. thick and are reinforced on both sides with ½-in. vertical bars spaced 24 in. c. to c., the steel being 3 in. from the outer face of the pier. Horizontal rods were placed at intervals and securely wired to the vertical reinforcement. The outer face of the arches has a radius of 18 ft., and the inner face conforms to a radius varying from 16 to 17 ft., according to the elevation. The under side of the crest is an arch of 16-ft. radius. The crest is heavily reinforced with ½-in. bars spaced 6 in. c. to c.

In the main channel there are nine sluiceports under three arches, each port having a clear opening 4 ft. wide and 2½ ft. high. The openings are provided with grooves 10 in. wide and 4 in. deep for the purpose of easy closure either by gates or flashboards.

At the west end of the dam is located the intake to the canal system. Three gate openings are provided, each

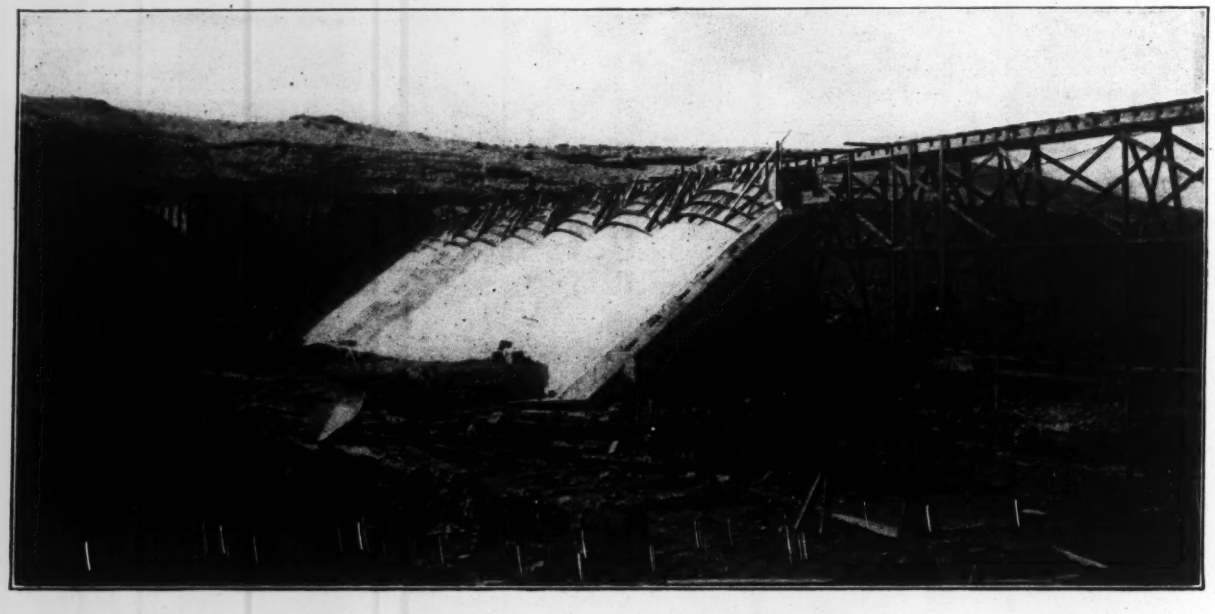


FIG. 3. THREE MILES FALLS DAM UNDER CONSTRUCTION

5 ft. wide and 6 ft. high, surmounted by a concrete gate house 12 ft. wide and 20 ft. long. Adjacent to the gate house and spanning the channel is a heavy concrete highway bridge 12 ft. wide. Beyond this the channel widens into a basin about 70 ft. long by 30 ft. wide. Across this basin there extends diagonally a wall consisting of nine piers connected by a base wall 3 ft. high and 9 in. thick. A walk 2 ft. wide and 6 in. thick connects the piers and with them outlines ten openings each 6 ft. wide and 5 ft. high, in which are set revolving fish screens.

Construction Details

The contractor began work by building a low earth coffer-dam to unwater the west part of the river channel. Rock excavation was promptly begun as soon as the river bed was uncovered. A screening, crushing and concrete-mixing plant was established at the east end of the dam. A trestle (Fig. 3) was built across the river parallel to the axis of the dam and on this trestle a narrow-gage track was laid, the elevation of the rails being 2 ft. above the crest of the dam. Cars pushed by hand were used, and by that method concrete and other material were easily distributed. A pit supplying fair sand and gravel mixed with boulders was found one mile from the dam. The output of the pit was run through the screening and crushing plant and divided into three grades—rock from 2 in. to 1 in., from 1 in. to ¼ in., and material passing a ¼-in. screen.

It was the endeavor of the contractor to complete as soon as possible that part of the dam in the section first unwatered and which contained the sluiceports. The remaining portion of the river channel was then unwatered and the current caused to flow through the sluiceports. Fig. 3 shows that part of the dam containing the sluiceports as nearly completed, the water flowing through the sluiceports and the east portion of the river channel bare. The cutoff trench and pier foundations were first excavated, then the trenches were filled with concrete. Forms for the piers were next constructed, and as fast as practicable filled with concrete. After the concrete in the piers was set forms for the arches were placed and the arches cast. They were cast in sets of from four to six, and two days were allowed to complete each set to about the elevation of the crest reinforcement.

The flow of the river was nearly uniform, approximately 120 sec.-ft., while construction was in progress.

Fig. 4. Downstream Face of Three Miles Falls Dam

Weather conditions were favorable. There were no accidents of importance. Construction progressed rapidly and closely to schedule, a result largely due to the efficient manner in which the contractor handled the work. On account of the rock lying in thin horizontal layers it shattered badly, rendering it necessary to excavate deeper and wider trenches than planned. This was especially true of the main cutoff trench, where rock was found to be badly fissured, and it was necessary to excavate to a depth of about 9 ft. in order to make a tight closure with sound rock. Instead of a cutoff wall 2 ft. thick with average depth of 4 ft., which it was hoped would suffice, there was actually built a wall averaging 6 ft. thick and having a depth of about 9 ft.

In order to close the sluiceports, concrete slabs, thoroughly reinforced, were cast, each 4 ft. 7 in. by 3 ft. by 7 in. with a wooden closing strip 6 in. wide and 1½ in. thick around the edge. The slabs were suspended from a

wooden framework above the sluiceports. Care was taken to clean the gravel from the sills of the ports, and by trial it was determined that each slab could be seated properly. On Nov. 28, 1914, at 10 a.m., the sluiceports were closed by cutting the ropes suspending the slabs and allowing them to drop into place. No difficulty was experienced. Some leakage occurs around the edges, but it is not thought worth while to attempt to stop it, as the probabilities are that the first flood will seal the openings. Fig. 1 shows the dam after the sluiceports were closed.

When the ports were closed there was about 120 sec.-ft. flowing in the river. At 7 p.m., Dec. 1, or about 81 hours after the ports were closed, water began running over the crest. There was little leakage under the dam, the total being less than ½ sec.-ft. There was almost no leakage through the arches, although there were several moist areas. Water passed over the crest in an even sheet, and the finished structure presents a pleasing appearance. An inspection made early in February, when 500 sec.-ft. was flowing over the crest, failed to disclose a single leak through the arches or piers, although, as previously mentioned, there were occasional damp areas.

Personnel

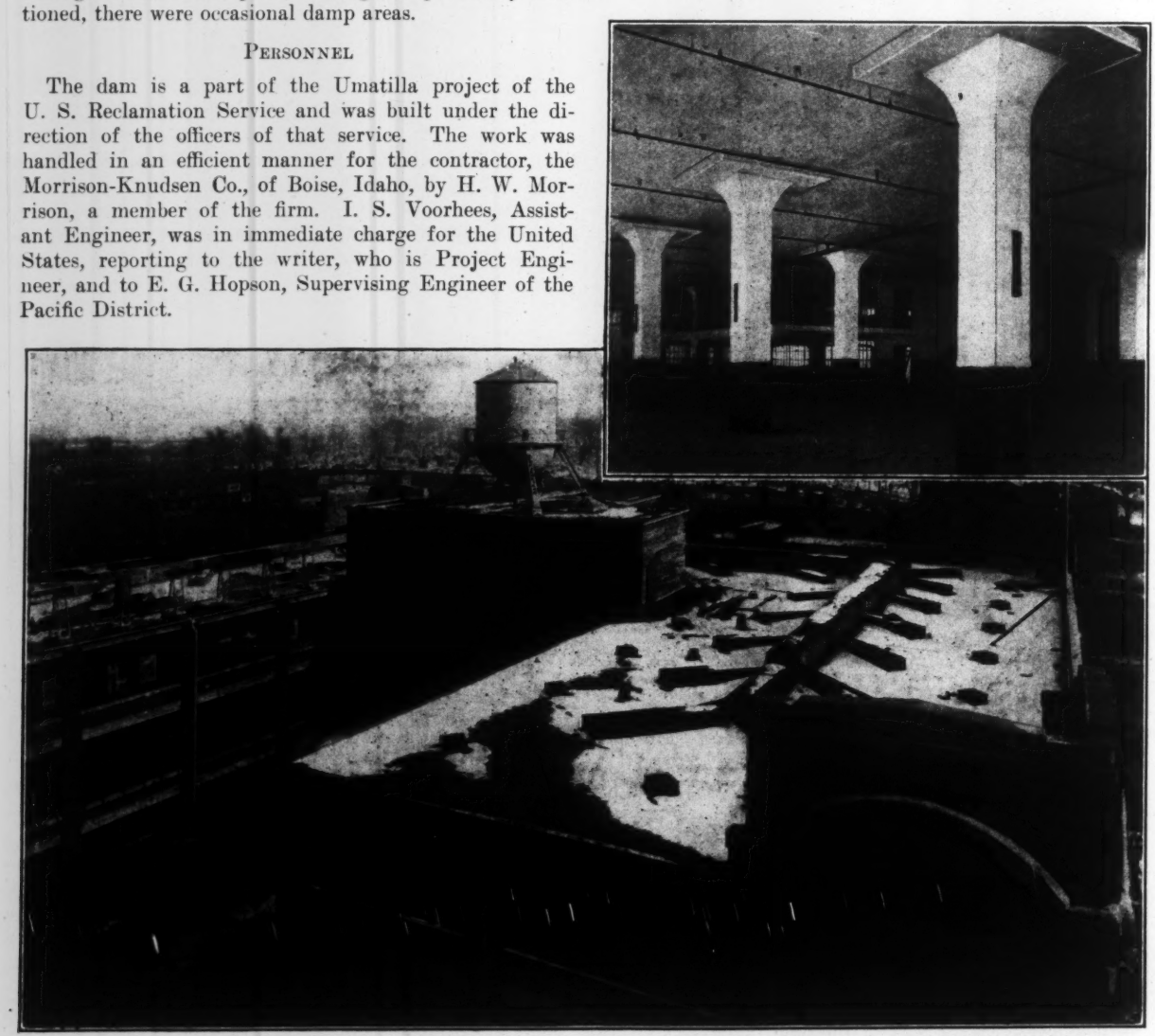
The dam is a part of the Umatilla project of the U. S. Reclamation Service and was built under the direction of the officers of that service. The work was handled in an efficient manner for the contractor, the Morrison-Knudsen Co., of Boise, Idaho, by H. W. Morrison, a member of the firm. I. S. Voorhees, Assistant Engineer, was in immediate charge for the United States, reporting to the writer, who is Project Engineer, and to E. G. Hopson, Supervising Engineer of the Pacific District.

The following tabulation shows the cost of the structure:

Excavation, rock, 5123.7 cu.yd. at $2	$10,247.40
Excavation, earth, 1539 cu.yd. at 65c	1,000.35
Concrete in place, 4157.6 cu.yd. at $9.75	40,536.60
Embankment and backfilling, 833.8 cu.yd. at 50c	416.90
Paving, 41.1 cu.yd. at $4	164.40
Handling reinforcement and other metal work, 51,900 lb. at 2½c	1,297.50
Handling water	900.00
Right-of-way, 68.1 acres purchased	2,162.60
	$56,725.75
United States material, mainly cement and steel	11,445.32
United States engineering	1,787.82
United States general expense	3,212.56
Total	$73,171.45

Factory with Down Ventilation Through Columns

In putting up a new factory building designed throughout for modern requirements, the Crown Cork & Seal Co., Baltimore, employed hollow concrete-and-steel columns, and downward ventilation through these columns, thereby eliminating all complications as to the distributing ducts.



Figs. 1 and 2. New Factory of Crown Cork & Seal Co., Baltimore, Md.
(View in one of the factory stories shows the vent-duct openings in the columns. Large view shows supply duct on roof)

The air heating, humidifying and fan system is grouped in a penthouse on the roof; the main ducts, distributing the air to the column ducts, are built directly on the roof.

The building is 210x170 ft., three stories and basement. The structure has beamless floor construction of the "mushroom" system. The wall columns are reinforced concrete, but a different construction is used for the interior columns, because of their serving as vent-ducts. Steel columns made of two built channels are incased in concrete, and themselves inclose the circular duct, which is formed by a galvanized-iron duct surrounded by the incasing concrete (Fig. 3). From top to bottom the ducts decrease in area, thus proportioning their capacity to the volume of air to be carried, and at the same time increasing the concrete area as the load increases. Outlets in each story, with deflector vanes inserted in them, deliver the air.

In building the columns the air-duct hollows were formed by placing the permanent galvanized iron lining of the duct and filling these with sand prior to pouring of concrete, to prevent collapse from the pressure. After the concrete had set, the sand was allowed to fall out of the bottom openings in the basement story.

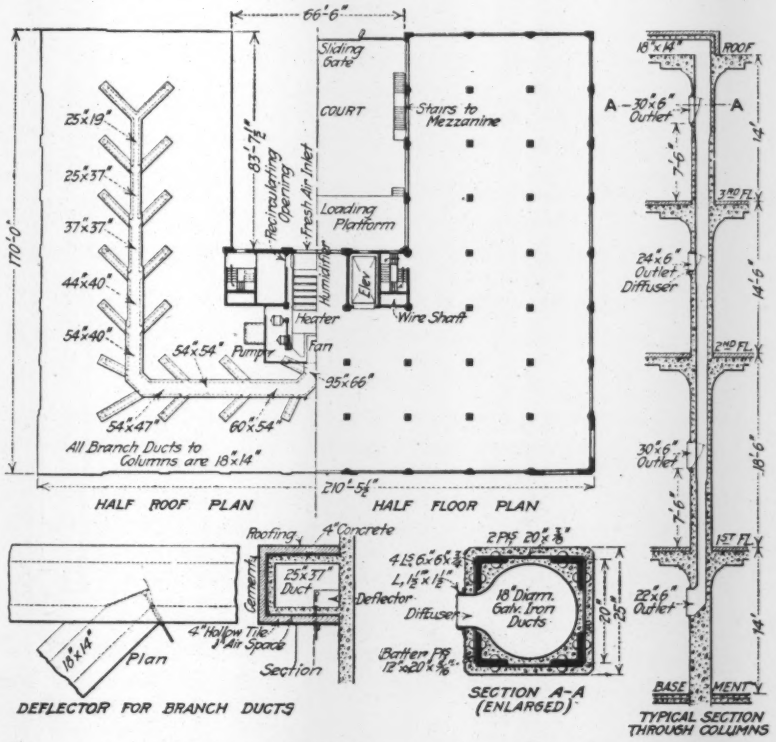


FIG. 3. ROOF AND FLOOR PLAN AND VENT-DUCT DETAILS

The construction of the main ducts on the roof is also shown in Fig. 2 by a sectional sketch. They are formed with double walls, 4 in. of concrete and 4 in. of hollow tile, separated by a 1-in. air space. The tile is covered with ¾-in. cement plaster, then asphalt, and then 5-ply slag roofing.

Of other features of the building the following may be noted: The exterior walls are brick curtain walls, with 70% of glass area ("Fenestra" sash glazed with hammered glass). The floors are of narrow maple laid on an under floor nailed to wood sleepers embedded in the concrete fill of the slab.

The use of wood floors is intended to avoid trouble from grit, etc., off the concrete, which it was feared might damage the delicate machines used; also, machine parts dropped on a concrete floor would be damaged. The roofing is slag except that a part is covered with tiles.

"Security" inserts were built into the floor slab at regular intervals to prevent much future cutting and drilling for shafting hangers and supports.

The operation of the heating and ventilating system involves drawing the air for heating in the wintertime through stairways and shafts from the various floors. In the summer the recirculating passages are closed and fresh air is taken from the outside, at the humidifier inlet on the roof. The air is humidified, heated in winter and distributed through the ducts.

The Position of the Engineer*

BY IRA O. BAKER†

I am persuaded that the chief reason why the engineer does not attain to the position in the public estimation which he might occupy is because of wrong ideals. The representative engineer magnifies the importance of technical matters; in college he is insistent upon acquiring a so-called practical education—that is, he desires to specialize and to take only the subjects immediately connected with his chosen profession. As a consequence, he lacks breadth of view and is weak in knowledge of nonprofessional matters. Too often he has sought to perfect himself in technical details to the neglect of a knowledge of political procedure, of business methods, of labor conditions, or of social problems. Further, he is often seriously deficient in the ability to use correct language.

What, then, can the young engineer do to prepare himself for a wider usefulness and a larger success? I have several definite suggestions:

By continual care and practice, cultivate the ability to express yourself in writing and in oral speech in clear, concise, correct English. There is nothing more necessary to the young engineer who desires to attain more than a mediocre success.

Extend your horizon by reading and study of industrial and political history, political and social science, economics, labor problems, principles of banking, rate regulation, and other vital subjects.

Do not become a man of technical details nor a man of books to the exclusion of a knowledge of affairs. The successful engineer must buy materials; therefore he must have a knowledge of market conditions and of business methods. A successful engineer directs the labors of others; therefore he must know much of the motives that influence men, and must understand the point of view of organized labor, and should have at least some knowledge of the advantages and disadvantages of the different methods of payment. An engineer is frequently called upon to report upon projects; therefore he should be able to foresee all the industrial, commercial and financial conditions involved in the project, and should be able to accurately discriminate as to the relative importance of the various conflicting factors. The engineer writes specifications and makes contracts; therefore he should know something of the intricacies of the law.

*Part of address before a convention of "Triangle," a civil engineering fraternity.

†Professor of Civil Engineering, University of Illinois.

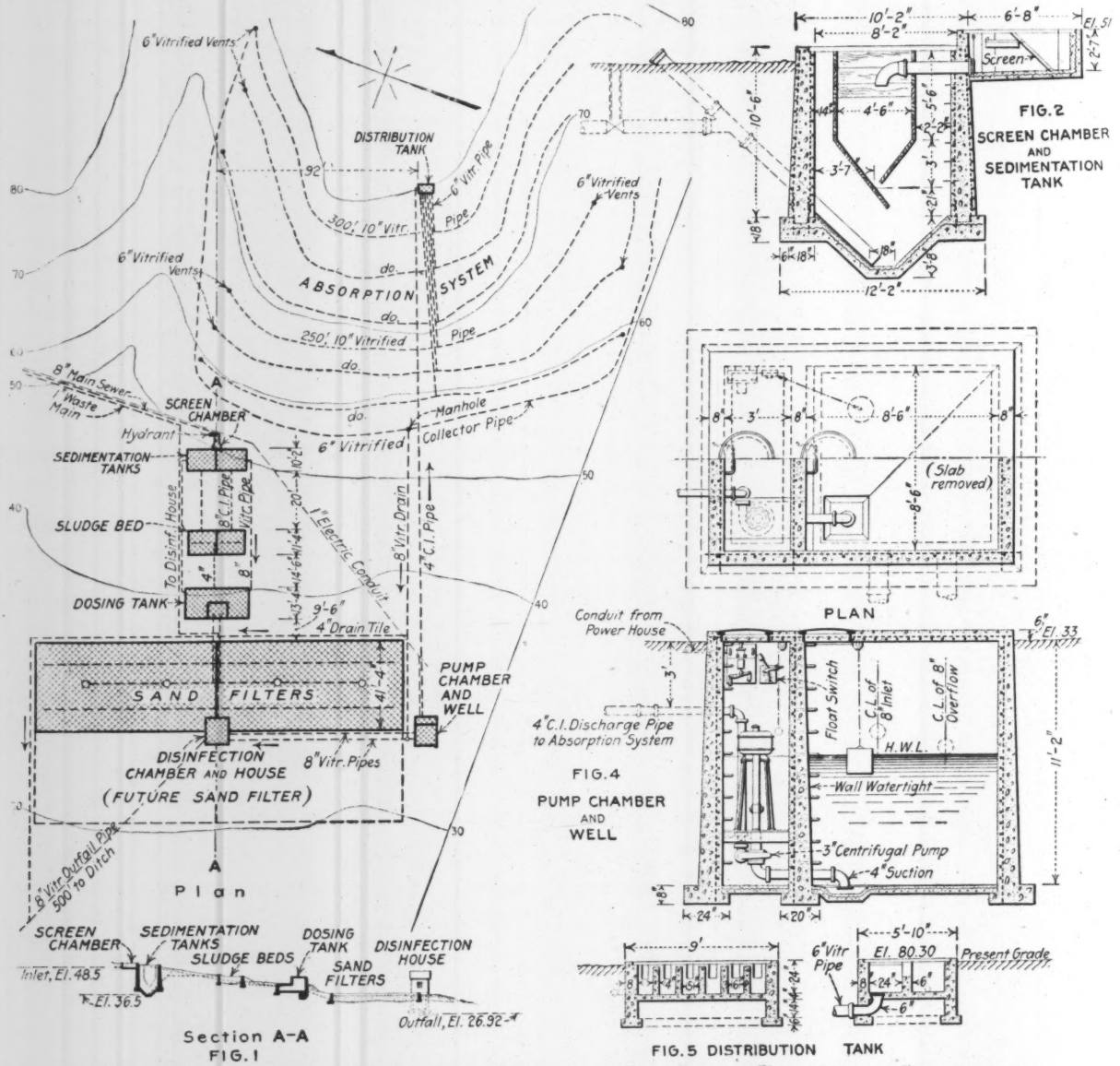
Sewage-Treatment Plant for a Small Sanatorium

By R. F. MacDowell*

Five counties in northern Ohio recently joined in the construction of a tuberculosis sanatorium at Springfield Lake, near Akron.† The buildings were erected on top of a hill, near a small inland lake, the land surrounding which is used as a pleasure resort and camping ground. The sanatorium farm is drained to the lake through a small ditch which affords no dilution for the sewage from the institution. Because of this, as well as from an æsthetic standpoint, therefore, it was necessary to provide a high degree of treatment for the sewage.

It is not expected that there will be, for several years, more than 250 persons residing at the institution, and the sewage-treatment plant was accordingly designed for this number, or 25,000 gal. of sewage per day, based on 100 gal. per capita. The plant, however, was laid out in such a manner as to permit its size to be doubled in the future. It is on the opposite side of the hill from, and entirely out of sight of, the five buildings of the institution, and the main sewer follows the contours around the hill to the plant.

The design (Fig. 1) includes a screen chamber, two sedimentation tanks of the two-story type, a dosing tank, a sludge bed, two intermittent sand filters, a subsurface absorption system and a disinfection equipment. The sewage flows by gravity through the screen chamber and one or both sedimentation tanks to the dosing tank, from which it is discharged by alternating siphons onto the sand filters. The filtered sewage is collected in a central



FIGS. 1, 2, 4 AND 5. SEWAGE-TREATMENT PLANT FOR FIVE-COUNTY TUBERCULOSIS SANATORIUM, SPRINGFIELD, OHIO

*Assistant Engineer, with R. Winthrop Pratt, Consulting Engineer, Cleveland, Ohio.

†The five counties were Portage, Stark, Summit, Mahoning and Columbiana.

chamber between the filters and then flows to a pump well, from which it is raised to the absorption system, located on the hillside above the sedimentation tanks. As a final precaution any drainage from the absorption system is collected and conducted back to the chamber between the filters, over which is the small building containing the disinfection tanks. Here the final effluent may be treated with a calcium-hypochlorite solution before being discharged into the near-by ditch. By means of gate valves and shear gates either the filters or the absorption system, or both, may be bypassed.

The screen chamber contains a single removable wrought-iron bar screen having 1-in. clear openings, the screen being placed at an angle of 45 deg. away from the flowing sewage. The sedimentation tanks, of the two-story type, are rectangular in shape and are placed end to end, a cross-section being shown in Fig. 2.

The tanks are constructed in excavation and have a total depth of 13.5 ft. They provide, when both are in operation, a "flowing-through" period of four hours and a sludge capacity sufficient for 180 days' storage, both based on the ultimate capacity for which the plant is designed. The tanks have 2-in. wood-plank flow compartment walls and 3-in. wood-plank covers, the latter being laid without

FIG. 3. CONCRETE SPLASH PLATE ON SAND FILTERS

joints to allow the gases to escape. The sludge may be discharged by gravity to the sludge beds, located adjacent to and just below the tanks. These beds, which have a total area of 240 sq.ft., are provided with bank sand, underlaid with washed gravel, making a total average depth of 15 in. By means of two removable wooden partitions they may be divided into four units for sludge-drying purposes.

The dosing tank is constructed entirely of concrete, with the central portion sufficiently high to provide headroom over the two 6-in. Miller alternating siphons located immediately below. By means of an emergency drain the tank may be entirely emptied at any time.

The sand filters are long and narrow, this being the most economical shape on the rather steep hillside. They are constructed largely in excavation and are surrounded by plain concrete walls. Instead of using the ordinary type of wooden troughs, which so quickly rot and become displaced, the sewage is distributed by means of a single line of cast-iron pipe running through the middle of each filter, under the surface, with riser pipes at two points discharging onto circular concrete splash plates, located at the surface of the sand, as shown in Fig. 3. The filtering material consists of bank sand having an average depth of 3 ft., and screened, washed gravel, the latter being placed only over the two lines of vitrified-pipe underdrains. The sand was obtained from a bank only one-half mile from the site and is of satisfactory character for the purpose. It has an effective size of 0.34 mm. and a uniformity coefficient of 2.20 after removing a small percentage of fine gravel by screening, and when placed was almost entirely free from loam.

The pump well is located at one end of the filters. The pumping equipment, which is placed in a dry chamber adjacent to the main chamber, as shown in Fig. 4, consists of a 4-in. vertical centrifugal pump, direct driven by a 7½-hp. electric motor. The pumping operation is automatic, being controlled by a float switch and automatic start and stop device. The electric wiring for power is carried in a conduit which is laid in the same trench with the sewer, from the power house about 1000 ft. distant. The effluent from each filter is thus quickly raised to a so-called weir or distribution chamber, located in the middle of the absorption system, 56 ft. higher in elevation than the pump. This chamber is designed to give an even distribution of the sewage to each foot of absorption tile. (See Fig. 5.) It is constructed of concrete and by means of concrete partition walls is divided into a main compartment and four smaller compartments. The sewage flows into the smaller compartments over weirs of different widths, corresponding to the different lengths of absorption lines. Each of the smaller compartments is connected to a separate line of absorption pipe, and thus the total quantity of sewage is divided proportionately among the different lines of pipe.

The absorption system consists of six lines of 10-in. second-grade vitrified pipe, each laid at a different elevation, but following closely the contour of the hill. A total of 1650 ft. of pipe was used, thus giving sufficient capacity, with each pipe half full, to receive the entire contents of the dosing tank.

Vitrified pipe, in 2-ft. lengths, was provided in place of the usual farm tile, as it was thought the pipe would maintain a better alignment. Each line was laid about 2 ft. deep, with a grade of 0.1 ft. per 100. The soil in which the absorption system was laid is of excellent character for the purpose, being a loose mixture of sand, gravel and loam. This material was found only at the top of the hill, and its character made pumping justifiable, although there was a sufficient area for the absorption system on land below the filters. As an additional aid, however, 4 in. of clean bank gravel was placed on the bottom and sides of the pipe. Also, pieces of tarred felt were placed over each joint to keep fine material out of the pipes. Down the hill from the absorption system an additional line of vitrified pipe was laid, also with open joints, for the purpose of collecting any drainage which may come from the absorption system. This drainage flows back to the collection and disinfection chamber between the filters. It is expected, however, that the ground will absorb the entire flow during most of the year.

The disinfection house, 10 ft. square in plan, is constructed of hollow tile, with a slate roof. The outside of the tile walls received a white stucco finish which gives a very attractive appearance to the building.

The disinfection equipment consists of two steel solution tanks, each 3 ft. in diameter by 5½ ft. high, and a small galvanized-iron orifice, or feed tank, together with solution and water-supply piping. The feed tank has a constant-head float valve and an adjustable orifice for regulating the flow of solution. The tanks are painted with acid-proof paint to protect them against the hypo-

chlorite solution. The final effluent, whether from filters or absorption system, will be thoroughly mixed with the hypochlorite solution in the 500 ft. of outfall sewer which discharges into the small ditch leading to the lake.

The plant was designed and the construction supervised under the general direction of R. Winthrop Pratt, Cleveland, Ohio. The contractor was the New York Sewage Disposal Co., of New York. The cost of the plant was $9000, including about 2000 ft. of sewers.

Standard Gate Valves of the New York City Water-Works

Four years ago the New York City Department of Water Supply, Gas and Electricity adopted six standard sizes of gate valves for use in the water-supply distribution system of the entire city. These six standards took the place of 12 or more sizes of valves used up to that time. During the past four years all renewals and additions to the distribution system have been made from the six standard sizes, the object being to gradually eliminate all other sizes. Table I gives the practice for installing the standard valves on different sizes of mains.

TABLE I. NEW YORK CITY WATER-WORKS STANDARD VALVES

	In.	In.	In.	In.	In.	In.
Diameter of main	6	8-10*	12-14*-16	20-24-30	36-42*-48	Above 48
Size of valve used	6	8	12	20	36	48

* Pipe of these diameters is not now used in extending the distribution system.

Where the diameter of the valve is less than the diameter of the main, standard reducers are used. The computed loss of head due to the reduction in diameter of the valve is such a small fraction of the frictional loss in the main that it is not considered as offsetting the advantages derived from the use of a reduced number of sizes of valves, as is indicated in the schedule (Table I).

Fig. 1 is a composite drawing of the New York City standard gate valves. Table II gives the principal dimensions of the various sizes of valves. Connections for a 6-in. bypass valve of special design (Fig. 3) are provided at the bottom, as shown in Fig. 1, on 36-in. and 48-in. valves. Special indicators showing valve opening are also provided.

Specifications

A brief abstract of some of the more important specification clauses follows:

CAST IRON—Good-grade foundry pig, admixed only when necessary with good clean machinery scrap, remelted in

TABLE II. PRINCIPAL DIMENSIONS OF NEW YORK CITY GATE VALVES

	Size of Valve	8-in.	12-in.	20-in.	36-in.	48-in.
A	Face to face of flanges	12	14	17	32	37
B	Diameter of end flanges	13	17	26	45	60
C	Thickness of end flanges	1	1	1	2	2
D	Depth of hub	3	4	4	6	10
E	Inside diameter of hub	10	14	22	39	52
F	Inside length of body	10	15	24	42	56
G	Inside width of body	5	7	10	16	21
H	Thickness of wall	1	1	1	1	2
I	Length of neck flange	14	19	30	51	67
J	Width of neck flange	9	11	16	25	33
K	Thickness of neck flange	1	1	1	2	3
L	Total length of stem	19	24	39	65	88
M	Height of valve O. A.	31	40	63	106	142
N	Center of port to top of hub nut	24	31	49	...	...
O	Center of port to center of pinion—bevel gearing	...	...	...	76	101
P	Center of pinion to top of bevel gearing	...	...	...	7	10
Q	Center of valve to top of pinion nut	...	...	...	18	25
	Ratio of teeth in bevel Gearing	...	...	...	35-15	52-13

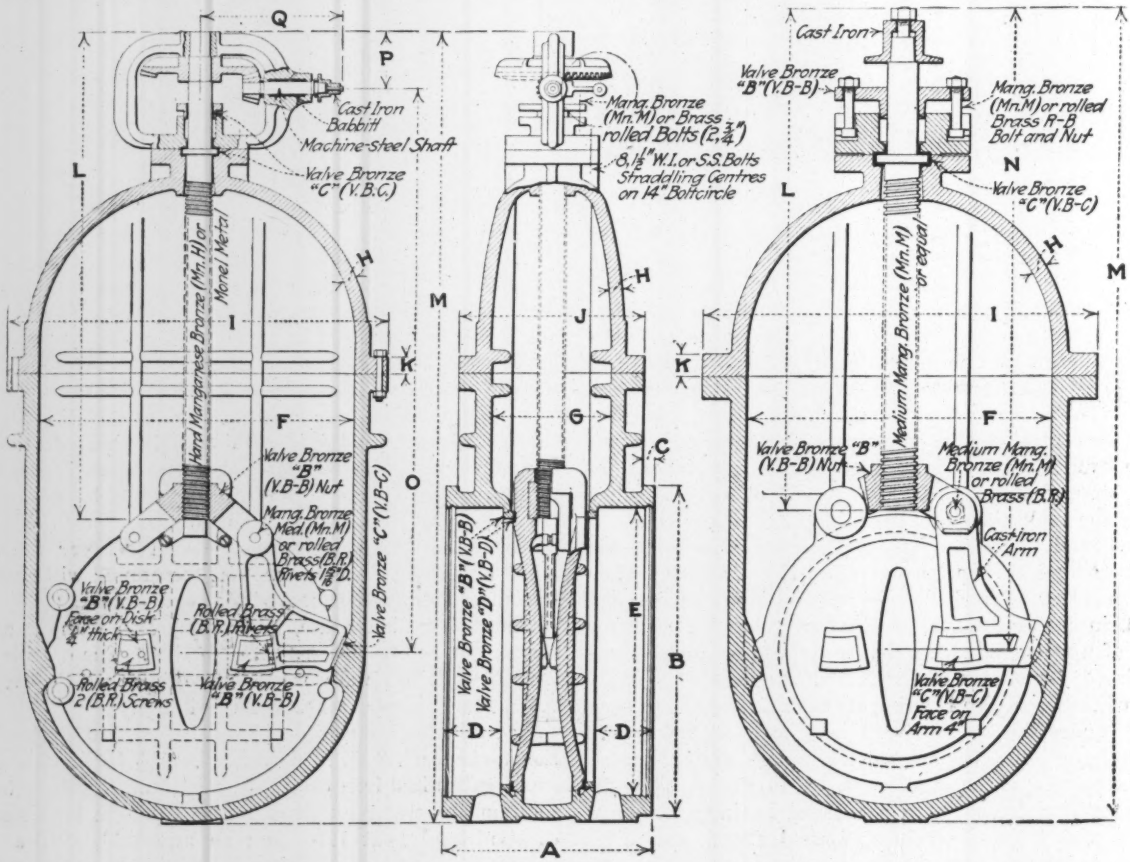


FIG. 1. COMPOSITE DRAWINGS SHOWING CROSS-SECTIONS OF STANDARD GATE VALVES OF THE NEW YORK CITY WATER-WORKS

cupola; as free as possible from sulphur—not over 0.1% in ½-in. or less castings and not over 0.11% in ½- to 2-in. castings; breaking strength of standard test bar 24 in. between supports, not less than 2000 lb. for ½-in. section, 2200 lb. for ½- to 2-in. sections and 2400 lb. for 2-in. and over sections; minimum deflection, 0.32, 0.33 and 0.34 in., respectively.

ALLOYS—Made of new metals, as shown in Table III.

WROUGHT IRON—Puddled iron, free from steel.

STEEL—Soft steel, same specifications as for structural steel for buildings of the American Society for Testing Materials; medium steel and machinery steel of tensile strength, 55,000 to 65,000 lb. per sq.in.

from 12 to 14 in. in diameter, stems are of medium manganese bronze, monel metal or other noncorrodible metal.

DISK RING—The disk ring is cast in one piece and hammered into a dovetailed groove provided in the iron casting. The back of disk ring is machine faced, and the sides of tongue are turned by machine.

FLANGE JOINTS—Joints between flanges are made with No. 1 jute board soaked for not less than one hour in an oil bath, or other sheet packing equal thereto.

PACKING—Valve stems packed with Tupper's packing, or equal thereto.

TESTS—Valves are subjected in shops to hydrostatic tests of 250 lb. per sq.in.

TABLE III. ALLOYS—(NON-FERROUS MATERIAL) CHEMICAL COMPOSITION

Letter	Name	Percentages—Composition—by Weight: Copper	Tin	Zinc	Lead	Iron	Nickel	Miscellaneous	Physical Properties Test Specimens Shall Show the Following Results: Ultimate Tensile Strength, lb. per sq.in. (Minimum)	Yield Point lb. per sq.in. (Minimum)	Percentage Elongation in 2 in. (Minimum)
VB-A	Valve bronze "A"	* 88	10	2	0	.....	.....		30,000	18,000	12
		86–90	9–11	3 (max.)	0.3 (max.)						
VB-B	Valve bronze "B"	88.5	8	3	0.5	.....	.....		30,000	15,000	..
		87–91	9–7	3 (max.)	0.8 (max.)						
VB-C	Valve bronze "C"	87	6	5.5	1.5	.....	.....		30,000	12,000	..
		85–89	5–7	6 (max.)	2 (max.)						
VB-D	Valve bronze "D"	90	0	6	4	.....	.....	Resulting material shall permit of hammering or peening.	.....	.....	..
		88–92	6 (max.)	6 (max.)	3–5						
†Mn-H	Mang. bronze hard	57	1	40	.....	1	.....	Manganese 0.5 (max.) Aluminum 0.5 (max.)	70,000	35,000	20
		54–62	2 (max.)	37–43		2 (max.)					
Mn-M	Mang. bronze med.	57	1	40	.....	1	.....	Manganese 0.5 (max.) Aluminum 0.5 (max.)	60,000	30,000	25
		54–62	2 (max.)	37–43		2 (max.)					
Mo	Monel metal	Rem.	.....	.....	.....	6.5 (max.)	60 (min.)	Aluminum 0.5 (max.)	70,000	35,000	25
B-R	Brass-rolled	60	0	Rem.	1.5	.....	.....		60,000	30,000	25
		58–66	15 (max.)		2 (max.)						
BM-A	Babbitt metal "A"	.....	10	.....	70	.....	.....	Antimony, 19 – 21 mixture shall be well fluxed with resin and borax.			
			9–11		68–72						

Note—The total amount of metals other than those specified for any alloy (nonferrous material) shall not exceed 0.3%.
* The numbers above the line are the desired percentages, and those below the line are the maximum and minimum allowable percentages of the various elements.
† The percentages are approximate and are given as a guide to the proportions of the elements that are expected.

DROP FORGINGS—Same specifications as medium steel.

MARKING CASTINGS—Castings have year of manufacture and letters "D. W. S." and initials or name of contractor and of foundry where cast, cast on the outer side in raised letters. Where a running number is required it is either cast or stamped on the castings, and if the casting is rejected the letters are erased by the contractor.

VALVE STEMS—For all valves 16 in. and larger in diameter the stems are made of hard manganese bronze, monel metal or other noncorrodible metal of equal physical properties and having a suitable chemical composition; for all valves

PAINTING—All iron surfaces subject to corrosion under exposure, either to water, earth or weather, are shop painted with two coats on the outer surface, one coat on the inner surface, of the best asphaltum paint.

Using these standard sizes, the number of valves and repair parts to be kept in stock is materially reduced. The time required to either open or close a valve is shorter and fewer men are required to close the valves, thus permitting quicker shutoffs in case of accident.

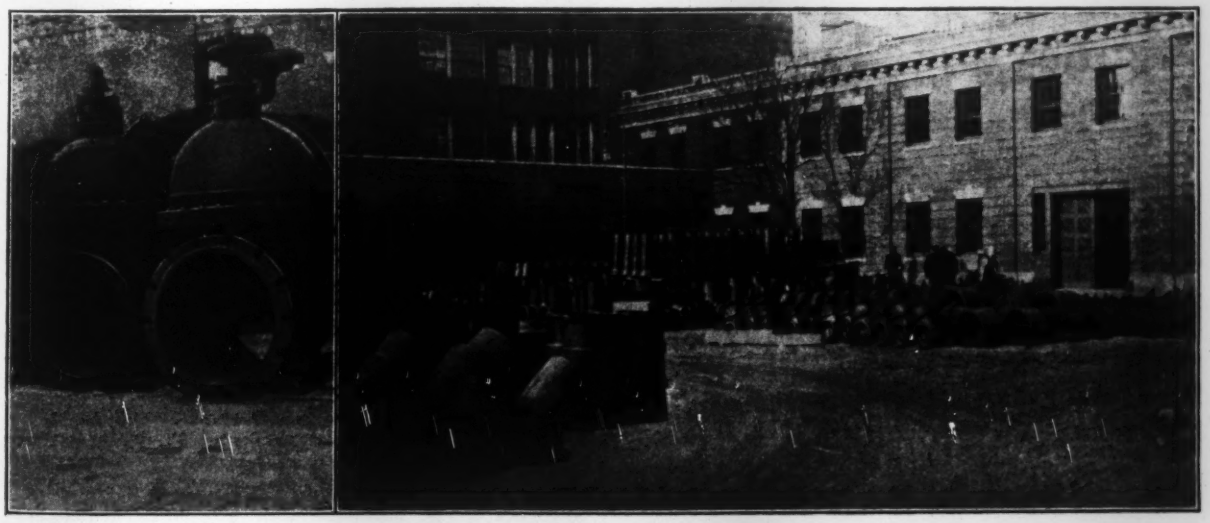


FIG. 2. STANDARD VALVES AND GENERAL VIEW OF EAST 24TH ST. YARD OF THE NEW YORK CITY WATER-WORKS

Cost Data—During 1914 prices of these valves purchased by the Department of Water Supply, Gas and Electricity were as follows: For 6-in., $12; 8-in., $18.50; 12-in., $34; 16-in., $65; 20-in., $115; 36-in., $600.

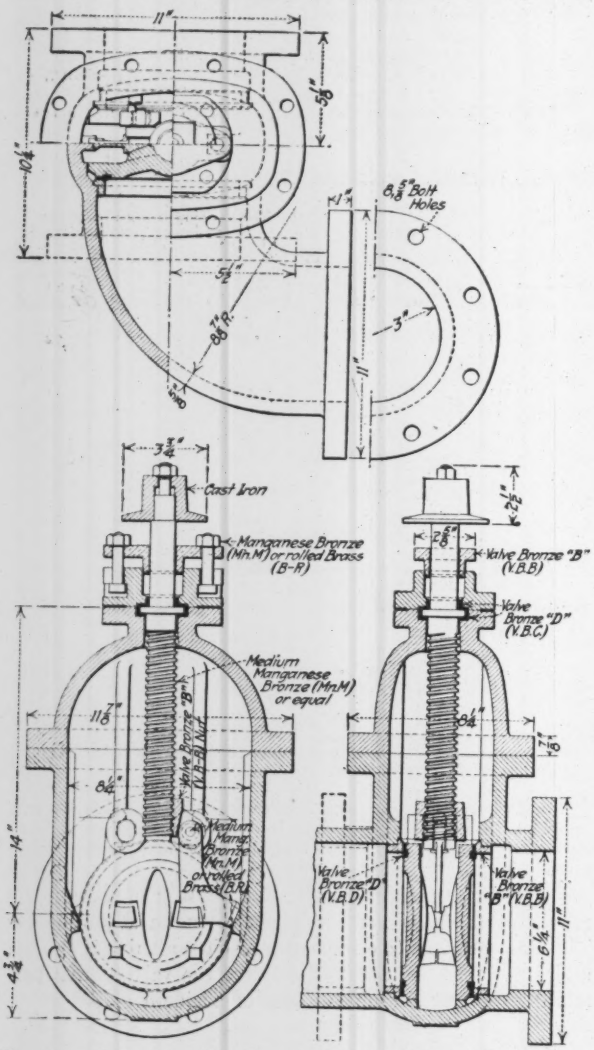


Fig. 3. Special 6-In. Bypass Valve, New York City Water-Works

(The standard 6-in. gate valve has the same dimensions and is shown in dotted outline)

The Chief Engineer of the Department of Water Supply, Gas and Electricity of the City of New York is Merritt H. Smith, and the Deputy Chief Engineer, W. W. Brush, to whom we are indebted for the data given.

Publicity for the Engineer and Its Importance*

By C. E. Drayer†

Why should we engineers be interested in publicity? Is there good reason for departing from the time-honored precept that our achievements are sufficient witnesses to their creator's ability?

He who molds together brick and steel and stone, it matters not with howsoever great cunning, will never rise in the estimation of those about him to a position above that of a skilled artisan. The engineer's mute witnesses of his ability are to the public mere piles of steel, long lines of railroads, or canals, or tunnels—just material things. The public must learn that we dream dreams and see visions long before a pound of material is shaped; that a part of our dreams is ever to subject the forces of nature so that man may develop the best that is in him, according to his destiny.

The man in the street is not likely to find this out unless we tell it to him in his own language. We have waited long enough for him to find it out unassisted, and our rewards bear evidence of the fruitlessness of our waiting. Unless we show that we are leaders, we will be only workers—hewers of wood and drawers of water.

There are other reasons for proper publicity conducted by engineers, all of which may be included in the broad purpose of service to the public. One of these is to correct error and misrepresentation so that when questions of public policy are up they will be decided in accordance with correct engineering principles rather than by the whim of the moment, directed, perchance, by some small class to further selfish ends.

The country is burdened with wastefulness where engineering skill might save vast sums. For instance, it is planned to spend a hundred millions of dollars on highways in New York State without adequate provision for maintenance. It is hardly possible that such a proposition would have been seriously entertained if the public had waited for the opinion of the engineering profession before making a decision. Again: Recently a proposition to spend fifty million dollars on good roads in Ohio was voted upon without any preliminary studies or surveys as to how the money was to be spent. Had the proposition been approved, the money would have been largely wasted under the direction of jockeying politicians.

At present the Government is spending millions of dollars and requiring the owners to spend many more in making a physical valuation of the railroads. When two vacancies occurred in the Interstate Commerce Commission a year or so ago, the suggestion was made to one who had the ear of the appointive power that it would be desirable to have one of the vacancies filled by an engineer. He replied that such a position required a judicial quality of mind, and that the incumbent could surround himself with all the expert service needed. His answer implied that an engineer could not be found possessing the necessary judicial quality of mind. It should be stated that the man who gave this reply was a lawyer.

There is a vast national field for furnishing engineering information to the public, which can be taken care of only by a permanent national information bureau conducted by engineers.

We have technical and research societies without number, so many that the public can hardly be blamed for believing that we are interested in material things only. Perhaps we need a national bureau to conduct and cultivate business relations with the public, including intersociety relations, publicity, employment, and legislation.

All over the country there is a growing protest against the direction of municipal affairs by the lawyer and the politician. The administration of municipal business is largely a function of engineering. Why not enable the

*From an address before the Engineering Section of the Chicago Association of Commerce, Apr. 23.

†Chairman, Publicity Committee, Cleveland Engineering Society, 1801 East 93d St., Cleveland, Ohio.

public to see this situation in its true light and thereby perform a public benefaction as well as advance our own interests? Positions for engineers would increase in number, likewise compensation. In the matter of seeking to prevent harmful legislation, recent events in this state are a sufficiently strong argument to convince Chicago engineers of the need.

Light Tractors for Industrial Service

The tractors shown herewith are intended for freight-house, shop and general industrial service, and differ from motor trucks in that they carry no part of the freight load.

Fig. 1 shows a gasoline tractor attached to a train of the three-wheeled carts used for hauling manure at the Chicago stockyards and delivering it at a siding where it is loaded upon railway cars by a traveling elevator tower in which each cart is raised to a dumping platform. The loaded carts weigh about one ton each, and the tractor hauls 10 to 12 carts in a train. Any kind of wagon or cart may be hauled by the tractor. It has been used for hauling a snowplow and street sweeper for cleaning streets.

The tractor weighs about 5200 lb., with 3800 lb. on the rear driving axle. It has 38-in. rear wheels and a 34-in. front wheel, with a wheelbase of 5 ft. 10 in. The single steering wheel gives such flexibility of movement that the machine can be turned within a circle of 7½-ft. radius. The connection of the frame to the front wheel is by means of a turntable with a ball bearing containing 98 steel balls ¾ in. diameter.

A small storage-battery tractor of the same type is shown in Fig. 2. This is in use for handling freight trucks in the 43rd St. freight station of the Chicago Junction Ry. The cost of trucking by hand trucks exclusively at this freight station for two months was 16.27c. and 17.37c. per ton, while for two other months in which the work was assisted by the tractor the cost per ton was 12.51 and 13.3c. respectively. The amount of freight handled daily averaged 1050 to 1150 tons, and the saving due to the use of the tractor averaged about $40 per day, or $1050 to $1100 per month.

These two tractors (known as the Bulley and Pullem tractors respectively) are built by the Mercury Mfg. Co., 4110 So. Halsted St., Chicago.

FIG. 2. STORAGE-BATTERY TRACTOR HANDLING FREIGHT TRUCKS

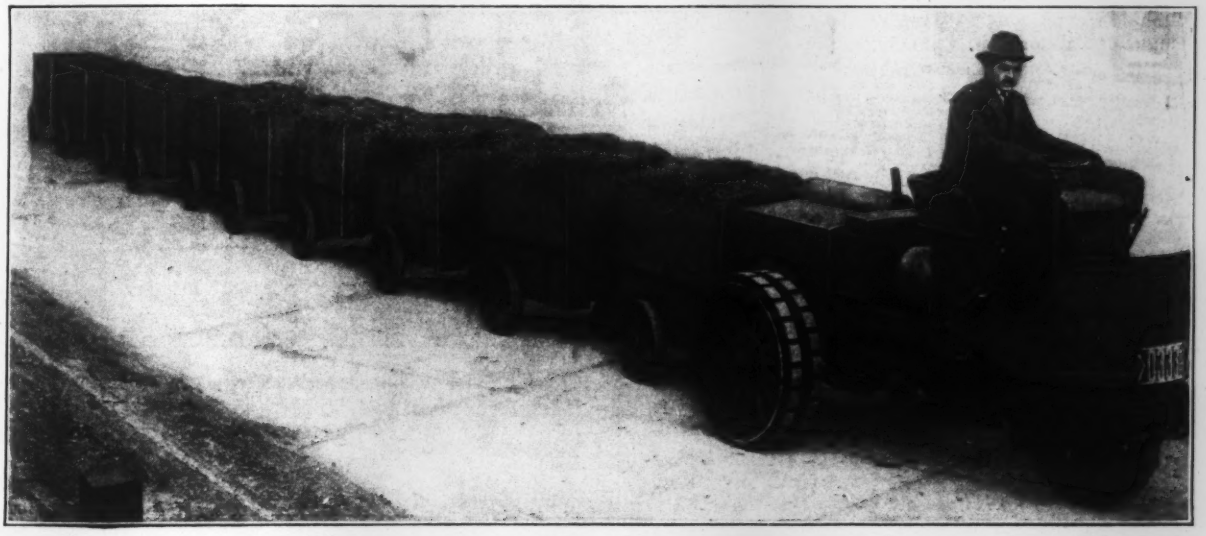


FIG. 1. TRACTOR WITH SEPARATE AND INDEPENDENT TRAILERS

The Water-Supply of Everett, Wash., has been investigated and reported upon by Burns & McDonnell, Consulting Engineers, Kansas City, Mo. The present supply is from several springs and small creeks, and the water-works, which were begun in 1892 by the Everett Water Co., include one main reservoir, three pumping stations and a hypochlorite plant. The distribution system comprises 73 mi. of mains. These were uncovered and examined in 200 different places, and the pipes in general were found in excellent condition. The distribution system is composed of 45.3 mi. of steel pipe, 17.7 mi. of wrought-iron pipe, 0.3 mi. of cast-iron and 9.7 mi. of wood-stave pipe. The average age of all the pipe was nine years. The present value of the water-works is estimated at $1,091,633. A proposed additional water-supply is the Sultan Creek project, which will give a gravity supply under 200 ft. greater head than the present supply. The chief feature of this proposed water-supply is 20 mi. of 28-in. water main, 30,000 ft. of which would be of steel pipe and 102,000 ft. of wood-stave pipe. The cost of the first is estimated at $4.95 per lin.ft. and the second at $1.80 per lin.ft.

Redressed Granite-Block Pavements

SYNOPSIS—Abstract of practice in the use of old granite blocks for street pavements.

The use of the old granite blocks as a foundation for asphalt has been far from satisfactory, although at one time this practice was extensively followed in New York City and elsewhere. It is not possible to keep a smooth surface on asphalt over old blocks under the present heavy motor-truck traffic, and a hollow once formed soon de-

FIG. 1. GRANITE BLOCK AS A FOUNDATION FOR ASPHALT, EIGHTH AVE., NEW YORK CITY

velops into an unsightly hole like that shown in Fig. 1 (Eighth Ave., New York City).

The question of replacing the old blocks with new ones or with another form of pavement of course depends on local conditions, but there is little excuse for scrapping the old blocks. Several cities have already demonstrated

FIG. 2. OLD GRANITE BLOCK, BOROUGH OF THE BRONX, NEW YORK CITY

that these may be economically disposed of by recutting or redressing them and relaying them under specifications for modern granite-block pavements.

BOROUGH OF THE BRONX, NEW YORK CITY—The practice of recutting old granite blocks and relaying them on a new concrete foundation is said to have originated with a paving contractor (William Booth) in the Borough of The Bronx, New York City. The first contract was let in September, 1909. Previous to that time the old blocks had been considered practically valueless, and the contractor had paid on an average only $6 to $7 per M for them, generally to crush and use the stone for concrete. Under the first contract for redressed granite-block pavements, 20,000 sq.yd. of street surface was repaved at a contract price of $1.27 per sq.yd. for taking up, redressing and relaying the blocks, and $4 per cu.yd. for a 1:3:6 concrete foundation 6 in. thick.

Since then about a quarter of a million square yards of pavement have been laid in The Bronx under similar specifications, the average cost of which has been $1.90 per sq.yd., including a new 6-in. concrete foundation. Fig. 2 shows a typical granite-block pavement before repaving, and Fig. 3 a pavement of the redressed cement-grouted blocks.

The more important clauses of the specifications read as follows:

The redressed granite blocks shall be 6 to 12 in. long, 3½ to 4½ in. wide and 4¾ to 5¼ in. deep.

All blocks shall be split and dressed to a substantially rectangular shape, with fair and true surfaces, so as to form,

FIG. 3. NEW REDRESSED GRANITE BLOCK, BOROUGH OF THE BRONX, NEW YORK CITY

when laid, close end joints and side joints not exceeding ½ in.

Between, in and 1 ft. outside of railroad tracks, over vaults, around sewer manhole frames, and in such places as required, the contractor shall use for the pavement stone blocks of such other dimensions as may be directed, but the same general dimensions on the top surface shall be maintained.

The blocks will be inspected after they are brought on the work, and all which, in quality and dimensions, do not conform to these specifications will be rejected.

The contractor will be required to furnish as many and only as many laborers as may be directed to aid in the examination and culling of the blocks, and in case the contractor shall neglect or refuse to do so, such laborers as may be deemed necessary will be employed and the expense incurred will be deducted and paid out of any money then due or which may become due to the contractor under this contract.

The work shall be prosecuted in sections not less than one city block in length, except when the blocks are over 300 ft. in length, in which case the sections shall be not less than 150 ft.

The contract prices for granite-block pavement shall cover the cost of all labor and materials required to furnish

and lay the pavement as specified, including the sand bed, mortar joints and expansion joints, the cost of taking up, redressing, storing and relaying old blocks when required, the cost of furnishing and laying such additional blocks as may be necessary to make up any deficiency of old blocks, the cost of furnishing such samples for testing as may be required, and the cost of maintaining the pavement in good condition as required by the contract (1 yr.).

In beginning the work the old blocks on one side of the street were first loosened, removed and piled on the sidewalks. They were then taken by the clippers, who split each block into halves or quarters, depending on the size of the old blocks. Where the clipping consisted of one split and dressing the edges only, the cost was as low as $10 per M; redressing to fulfill the size requirements of modern first-class granite blocks costs about $25 per M. The old blocks laid on an average about 22 blocks to the square yard, and the new ones 38 blocks to the square yard, so that there is always a surplus of material.

The clippers are men with quarry experience and work independently or in pairs, dressing the old blocks at so much per thousand. They work on the street in advance of the repaving, and the redressed blocks are thrown into piles in the middle of the pavement area, where they are culled, counted and piled on the sidewalk.

SCHENECTADY, N. Y.—Schenectady has only about 50,000 sq.yd. of granite-block pavement. In 1913, under Charles A. Mullen, Commissioner of Public Works, it was decided to repave portions of Albany and State St. by taking up the old blocks and splitting them into quarters. The old blocks were 12x4 in. by 8 in. deep, and the new blocks 6x4 in. by 4 in. deep, which gave 100% increase in surface area. The old blocks were pried up and piled on subgrade, cut by clippers and thrown into piles. Very little grading work was necessary, as only a 4-in. concrete foundation was placed under the new blocks. The recut blocks were laid on a shallow dry-mortar bed, and as soon as several square yards had been laid and rammed the pavement was flushed to thoroughly dampen the mortar bed. A total of 10,000 sq.yd. of such pavement was laid by municipal day labor at a cost of about $2 per sq.yd. The foreman received $4 per day and the clippers and pavers $5 per day each.

FIG. 4. REDRESSING GRANITE BLOCKS, SCHENECTADY, N. Y.

NEWARK, N. J.*—In this city some 33,000 sq.yd. of napped, reclipped, grouted granite-block pavements have been laid since 1913. The blocks used were mostly made from those removed in repaving a portion of Broad St. with wood blocks in 1911. These old blocks were kept by the city and are being sold to contractors for use on

*Data given under Newark, Philadelphia, Troy and Trenton are from a paper by William A. Howell, Engineer of Highways, Newark, N. J., read at the meeting of the American Society of Municipal Improvements, October, 1914.

napped granite-block pavements at $30 per M. A block-maker in an 8-hr. day can nap and reclip 175 large blocks into 350 small ones, which run about 42 to the square yard. The contract price of these pavements in Newark has ranged from $1.77 to $2.73 per sq.yd., complete with a 6-in. concrete foundation. The average price is about $2.50 per sq.yd.

At the present time the city of Newark is giving employment to a number of men by having an accumulation of old blocks redressed. The work is done in a vacant lot and under careful supervision. The redressed blocks must conform to the following requirements:

Not less than 6 nor more than 12 in. long; not less than 3½ nor more than 4½ in. wide; and not less than 5 nor more than 5½ in. deep. There must be no deviation from a straight edge on the surface of the head of the block greater than ⅜ in. The block shall be dressed so that after laying, a measurement of the individual joint shall show a width of not more than ½ in. at the top and for a depth of 1 in., and a width of not more than 1 in. in any other part of the joint. The blocks must not have any seams, scales or discolorations showing signs of disintegration.

The cutters are paid 2½c. for each block accepted by the city. It has not been definitely decided as yet what price to charge contractors for the finished blocks. All paving work in Newark is done by contract. No attempt is made at the yard to sort granites from one particular quarry or granites of a particular variety, but this may be done on the street.*

PHILADELPHIA, PENN.—Only about 10,500 sq.yd. of reclipped granite blocks have been laid in this city. The cost was $1.43 per sq.yd., including sand cushion, but not a concrete foundation, which was already in place.

BOROUGH OF MANHATTAN, NEW YORK CITY—An experimental pavement of redressed granite blocks was laid in 1914 on Avenue A between 54th and 57th St. The redressing was so well done that the finished blocks practically fulfilled the specifications for new granite-block pavements (⅜-in. joints). This resulted in waste that required about one-third of the pavement to be laid with new blocks. Both grout and bituminous filler were used. There was practically no economy in cost as compared with new granite blocks.

FIG. 5. OLD BLOCKS, NEWARK, N. J.

FIG. 6. REDRESSED BLOCKS, NEWARK, N. J.

FIGS. 7 AND 8. REPAVING STATE ST., ALBANY, N. Y., WITH REDRESSED GRANITE BLOCK

*From information received from William A. Howell, Engineer of the Department of Streets and Highways, Newark, N. J.

TROY, N. Y.—This city has repaved many streets with redressed blocks, made from blocks put down 30 to 40 years ago. The contractor was required to take up the old blocks, remove them from the street to any vacant lot he could hire and there split and redress them. The blocks were then relaid on a new 4-in. concrete foundation at the price bid of $2.30 per sq.yd., including a 5-yr. guarantee. Where the street had car tracks the price was $2.40 per sq.yd. The contractor was required to split all the old blocks, although this gave an excess of 25% over the number necessary for repaving. For these the contractor received $15 per M delivered to the city engineer at any point within a radius of half a mile of the place where they were cut.

TRENTON, N. J.—Here a few thousand square yards of redressed old granite blocks have been relaid at a contract price at $1.58 per sq.yd., including a 5-in. concrete foundation.

BALTIMORE, MD.—Since the Baltimore Paving Commission began its extensive repaving program in 1911 about 10,000 sq.yd. of redressed granite-block pavements have been laid. The city still has nearly three-quarters of a million square yards of old granite-block pavements, most of them being of blocks of large size—14x6 in. wide by 8 in. deep. Redressing these to make four new blocks has cost about 2½c. per finished block. The redressed blocks are laid on a 1:3½:7 concrete base. The average contract price has been about $1.80 per sq.yd., not including the foundation.

ALBANY, N. Y.—During 1914 the downtown section of State St. was repaved with reclipped granite blocks (see Figs. 5, 6 and 7). The old pavement was laid on a 14-in. gravel base and had been down since 1889. The old blocks were split and redressed in the street and then piled on the edge of the sidewalk. When the old blocks had been redressed and removed the street was graded for the 6-in. concrete foundation. The clippers were paid 1c. per block finished, and the average number of blocks made per man per 8-hr. day was 600. The recut blocks laid about 36 to 38 per sq.yd. The contract price was $2.24 per sq.yd., including foundation and grading. On other streets the cost has varied from $2.19 to $2.76 per sq.yd. In all, about 64,000 sq.yd. of redressed old granite blocks have been laid at an average contract price of $2.42 per sq.yd.

The Albany specifications read as follows:

The stone blocks shall be granite of a durable, sound and uniform quality, each measuring on its face or upper surface not less than 6 nor more than 12 in. in length, and not less than 3½ nor more than 4½ in. in width, and not less than 4¾ nor more than 5¾ in. in depth. All of the stone shall be of the same quality as to hardness, color and grain; no outcrop, soft, brittle or laminated stone will be accepted. The stones from each quarry shall be piled and laid in separate sections of the work, and in no case shall the stones from different quarries be mixed.

The blocks are to be split and dressed so as to form, when laid, close end and side joints not exceeding ½ in. in width, with fair and true surfaces on the top, bottom and ends. Not more than one drill hole shall be shown on the head of the block and none on the ends, an allowance of not over an average of one block showing drill holes on side shall be permitted to a square yard.

Care shall be exercised in handling the blocks so that the edges and corners shall not be chipped or broken, as blocks otherwise acceptable may be rejected on account of spalling. The head of the block shall be so cut that it shall not have more than ¼-in. depression from a straight-edge laid in any direction across the head and held parallel to the general surface of the blocks.

The blocks shall be piled on the sidewalks, and openings shall be left so as to enable property owners to use the street, and the blocks shall be kept at least 6 ft. from all fire hydrants. The work shall be so arranged and the distribution so made that the blocks shall not be piled on the street for more than two weeks before being laid.

The blocks of the dimensions above named shall be distributed generally throughout the street so as to produce non-uniformity in the length of the stones. The crown and widths of the carriageway shall be as directed by the city engineer.

Each course of blocks shall be of uniform width, and so laid that all longitudinal joints shall be broken by a lap of at least 3 in., and all side and end joints must be less than ½ in. in width, with all joints as close as the blocks can be laid. The blocks will be laid with their longest dimensions perpendicular to the center line of the street and upon straight lines across the carriageway. At street intersections they shall be laid as directed by the city engineer.

FIG. 9. STATE ST., ALBANY, N. Y., PAVEMENT BEFORE GROUTING

The blocks shall be laid on a bed of sand of the quality and depth already specified. This bed must be prepared for a distance of at least 25 ft. in advance of the laying of the pavement. None but practiced and competent pavers shall be employed in laying the blocks.

CONCLUSIONS—Nearly all the specifications, except those sections relating to the blocks and the method of dressing them, are the same as those required for first-class modern granite-block pavements, which cost on an average of from $3 to $5 per sq.yd. The officials of the cities which have tried redressed granite-block pavements have reported no fault to be found with them; they have obtained what proves to be substantially a first-class granite-block pavement at one-half to two-thirds the cost of a pavement of new blocks. The size of the recent blocks is not material provided they are at least 4 in. deep.

Changes in the Building Business

By M. C. Tuttle*

No business is undergoing more rapid evolution than the business of building construction. At present the best of the old order still exists beside the new, and one can see the old type of builder or "contractor" still holding his own in competition with the new type of builder, commonly a corporation known as this or that construction company.

Still doing business and building with a technical skill that is the envy of younger men are gray-haired men who will tell you of the building done after the great Boston fire, when the builders made bids by looking at the lots, and of the times when a builder made bookkeeping simple by opening a new bank account for each job and only opened his mail when asked to pay a bill. The best of these men are mines of information, and their knowledge of building matters astonishes younger men. One of these—the dean of all modern builders, still actively at work—has erected three buildings on the same lot, each intended to stay for all time; and he has trained many of the leaders of the building business in the East. I remember the quieting effect a few years ago on one young salesman who thought his firm was introducing cast concrete when this senior master-builder showed him a wheel window that he had cast in concrete about the year the younger man was born. The courts have just affirmed the validity of a patent covering one of the latest types of reinforced-concrete construction which was granted to this man, who wears the G. A. R. button and who began building before steel was invented.

Certain buildings in Boston built by men of this stamp do me good each time I see them. They are so well built, so obviously free from need of repairs, and so much better than the ordinary in workmanship that it seems to me that anyone outside or inside the building trade must see they are better and would insist that a man who can build like that should be always building. Yet these old builders are generally losing ground to their younger competitors, partly because age always lets youth take its place and partly because the new organization is inherently more efficient than the old. It may be interesting to note some of the changes in method between the new and the old school of builders.

Selling, with its accompaniment of advertising, has come into the building business within the last 18 years. Reinforced-concrete construction was originally taken up not as a builder's but as an engineer's business. Engineers, however, for years failed to realize that there was no lack of mathematics but a sad lack of practical knowledge as to the handling of this new material. Because engineers working in reinforced concrete lacked this practical knowledge they were driven to organize departmental management, and because the material was new they had to go out to introduce it. To this end they studied publicity methods. Recalling the history of one such company, I know there were for a dozen years many builders who could have handled the work done by this company as well as or better than it was handled, yet the builders failed to get the work because they did not practice any active selling methods. In time the newer company learned its business, and learned also to show those who were interested what it had learned. One of the best old-school builders in my city refused to write to a man who was about to build, saying that this man had seen his work on several occasions and if he had sense he would send for him. My point is rather blunted by the fact that the old-school builder was finally sent for because this particular owner knew real building work when he saw it; but in most cases a firm with a good selling force will secure more work than an equally able one without such a force. Real selling in any line includes the honest recognition of the needs of the buyer and in general simply means explaining how these needs are to be supplied.

Largely as a result of these selling methods has come the agitation for obtaining work on other bases than the lump-sum bid. Where firms have been able to establish their reputation for honesty and ability they have been able to obtain their business on a basis that secures their coöperation on problems on which they are competent.

The advertising of the construction companies has unquestionably had a considerable educational effect on the whole building trade. It has emphasized and made plain the qualities that lead to success, has discussed the details of organization and has made more nearly universal the standards of quality and of performance.

One pleasant feature of the publicity work has come from the willingness of various construction companies to discuss frankly, giving costs and full description of methods, the details of their work. Because of the advertising value to themselves, they have given freely the information which the old-line builder held as a trade secret. In discussing their costs they have gone on the theory that, to make those costs, other builders must be as clever as they are. They realize that costs are measures of performance, not trade secrets—an idea which seems to have been hazily in the minds of the older line of builders. I know today of builders who will not tell you how much a thousand they estimate for brickwork, nor how much a thousand it costs them, even though the methods of determining a thousand of brick are nearly as numerous as the firms using the methods.

It seems that the opening up to a free discussion of the matters which have not been freely discussed is certainly an advantage to everyone connected with the building trade. This has tended toward the establishment of common practices of measurement and common practices of cost-keeping and has brought matters onto a common ground of understanding, where the builder and the architect or engineer can intelligently discuss the business affairs which concern them. In general the advertising of the modern building business is largely tending to establish the reputation of the concern for frankness and intelligence.

The business methods of the modern construction company vary from those of the old-time contractor principally in carrying departmentalized management further than it has been carried heretofore. Such a company usually has a general manager who is primarily a business man. He must of necessity readily understand the details of all departments. Under him, and settling all but the principal question of policy, are the department heads, who handle the accounting,

*Secretary, Aberthaw Construction Co., 8 Beacon St., Boston, Mass.

the cost-keeping, the engineering, the buying, the employment and the conduct of the jobs. Each of these jobs is organized with a general superintendent and an organization more or less following the lines of the parent company. Such an organization, properly knit together, tends to more rapid and accurate handling of the work than did the more personal set-up of the old-time contractor's organization. The men who settle questions are perhaps likely to settle them on a little broader basis from the fact that they are at least once removed from the gain or loss of the business. The danger of the situation is that the organization may lack the personal pride in the work which the best men of the old order always had.

It has seemed to the writer that for the few jobs that the old-line contractor could handle with the force which he had trained nothing has yet equaled this method of building. Of all the construction work which the writer remembers, the very best has been done by the personal effort of some individual builder who threw his own personality and his own reputation into that job. The men who can do this are comparatively rare. If this were not the case the modern construction company could not stand up against the competition of the excellence of the work which can be obtained in this way.

After a number of years of careful study of the building business, the writer believes that excellence of work is the only competition that a firm need fear. Apparently clever building companies have failed because their work was not good, and from time to time they have got work from men who knew how to handle it thoroughly well. Yet in the end the firms that have really built well have grown prosperous. There is today, more than there has been before, a demand for the best in building work. We are hearing oftener than we used to the statement that a given firm turns out a proper quality of work. It is interesting that the firms who do get this name for quality also obtain the volume, and the best of the modern construction firms hold their standard for quality very steadily. This increasing appreciation of the builder's skill is one of the pleasantest points of modern building.

Test of Load-Distributing Action of Floor Arches

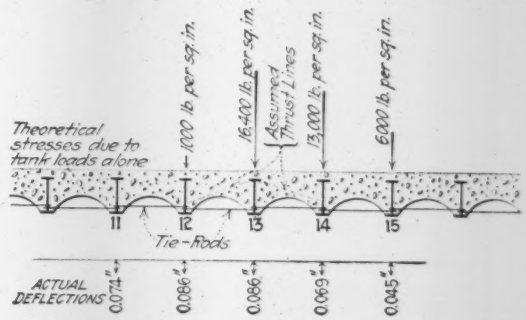
By Frank N. Kneas*

An unusual test was made recently under the writer's direction—measuring the deflections of several steel beams in a floor to discover the probable amount of stress in certain beams. Some of the beams in this floor were to have concentrated loads placed on them, while adjacent beams were to be practically unloaded; a change had evidently been made in the loading of the floor from that considered in the original design. The floor under the new conditions was to carry horizontal cylindrical tanks resting in cradles supported on pedestals, some of which would come directly over a beam. The question was, Would the floor arches act in such a manner as to transfer some of the load from the high-stressed beams to the adjacent low-stressed beams?

The subjoined sketch shows a cross-section through the floor—20-in. 65-lb. I-beams spaced 38 in. on centers and spanning 22 ft.; reinforced-concrete arches between the beams with rise of 10 in., top of concrete about 4 in. above the beams, and arch about 14 in. thick at the crown.

Disregarding the bridging action of the concrete, the theoretical stresses *due to the pedestal loads only* ran up to 16,000 lb. per sq.in. for certain beams, while adjacent beams were apparently stressed as low as 1000 lb. per sq.in. In one case the theoretical deflection at the center was $\frac{3}{8}$ in. for one beam and only $\frac{1}{40}$ in. for the next beam. It seemed impossible that this could occur; more likely the concrete would "drag" the adjacent beams down with the heavily stressed beams, and thus reduce the stresses in the latter.

To get definite information on this distributing action it was arranged to measure the actual deflections. Instruments were erected under about 12 beams, as well as under the girders on which the beams rested; the instruments multiplied the deflections by 20, so that it was possible to get very accurate measurements. The loading



Floor Tested for Distributing Action under Heavy Concentrations

of the floor was very simple—it consisted of filling the tanks with water. The tanks were emptied after 48 hr., to determine the amount of deflection that the beams would recover.

Inasmuch as the beams were spliced over their girders and the concrete around the top flanges of the beams acted as part of a T-beam, the actual deflections were much less than the figured deflections. Of course, the deflections for the dead-load were already in the beams before the tanks were filled, so that the deflections actually read were for the water loads only. Consideration was given to the deflections in the girders on which the beams rested, corrections being made in all deflections of the beams due to the deflection of the girders. But the corrected comparative deflections of the beams proved very interesting and are shown in the sketch.

Although the theoretical stresses in the beams (the concrete not counted as part of the section) differed so greatly, yet the deflections were very uniform. It is evident that a considerable portion of the load was taken through thrust lines similar to those dotted on the sketch to adjacent beams, and that hereby the load was distributed almost equally over the five numbered beams.

The test is interesting not only in showing the distributing action of such deep arches on such close spacing, but also as indicating that in more regular floor systems, such as terra-cotta arches between steel beams, there may be similar action tending to distribute heavy loads (such as partition loads) from one beam to adjacent lightly loaded beams.

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The Largest Blast on Record

On Mar. 22 the Riverside Portland Cement Co., of Riverside, Calif., fired at its quarry what appears to be, so far as our records extend, the largest blast ever fired. The quantity of explosive used was 58 tons and it is estimated that between 350,000 and 400,000 tons of rock were broken by the blast. The largest previous blast of which we have a record was one at the Moreno dam, California, which was described by M. M. O'Shaughnessy, Chief Engineer of that work, in our issue of Dec. 30, 1909. In the blast at Moreno dam about 19½ tons of explosive were used and about 180,000 tons of rock were displaced.

In each of these very large blasts the explosive was placed by tunneling and drifting and not in churn-drill holes. The accompanying drawing shows the location of the tunnel driven at the Riverside quarry and the placing of the various charges of explosive. It will be seen that the tunnel was driven on the back side of the hill, oppo-

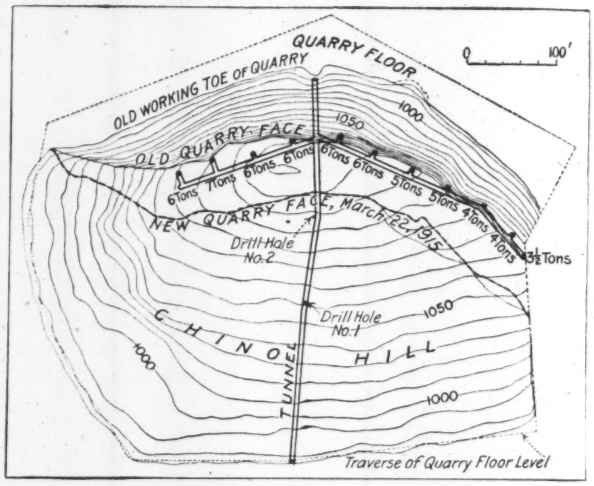

FIG. 1. MAP OF QUARRY SHOWING BLAST HOLES

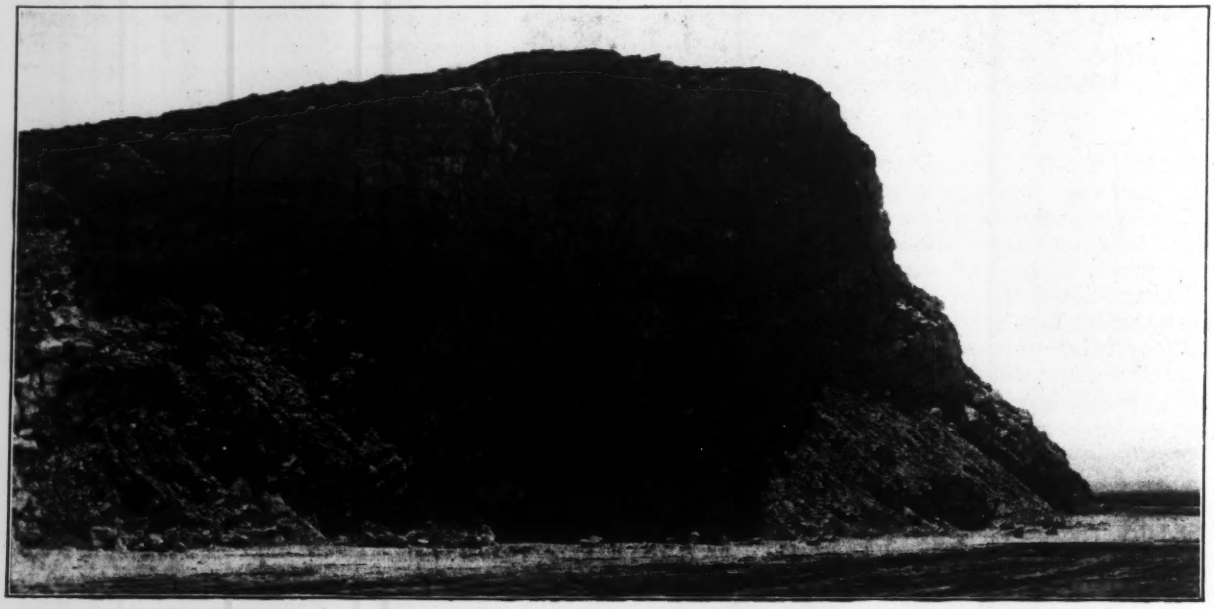

FIG. 2. VIEW OF QUARRY BEFORE FIRING

FIG. 3. VIEW OF QUARRY AT INSTANT OF FIRING

site the working face of the quarry and will be available, therefore, for future blasting operations carried on in a similar manner. The total amount of explosive used was 56½ tons of 5% Hercules R. R. P. explosive and 1½ tons of 40% and 60% dynamite. The explosives were placed under the direction of A. H. Crane, of the Hercules Powder Co., San Francisco.

The accompanying photographs show the quarry before, during and after the explosion. It is of special interest to note the extent to which the rock was broken up by the blast and the very small amount that appears to have been scattered. The Riverside Portland Cement Co., to whom we are indebted for the photographs and drawings, states that the blast was witnessed by many hundred persons and that it produced very little noise and scarcely any vibration, notwithstanding the large amount of explosive discharged.

The Use of Electric Arc Welding to build up flat spots on a locomotive tire was described in a recent issue of "Coal Age." Skilled workmen with the electric arc build up the flat spots with steel, which may be so highly carbonized with carbon from the arc that a tool will not touch it. After the tire is thus built up a portable grinding tool is used to smooth it and true it. By this method it is possible to remove flat spots from a tire without taking out the wheels from under the locomotive, thus greatly reducing the time it is necessary to keep the locomotive out of service.

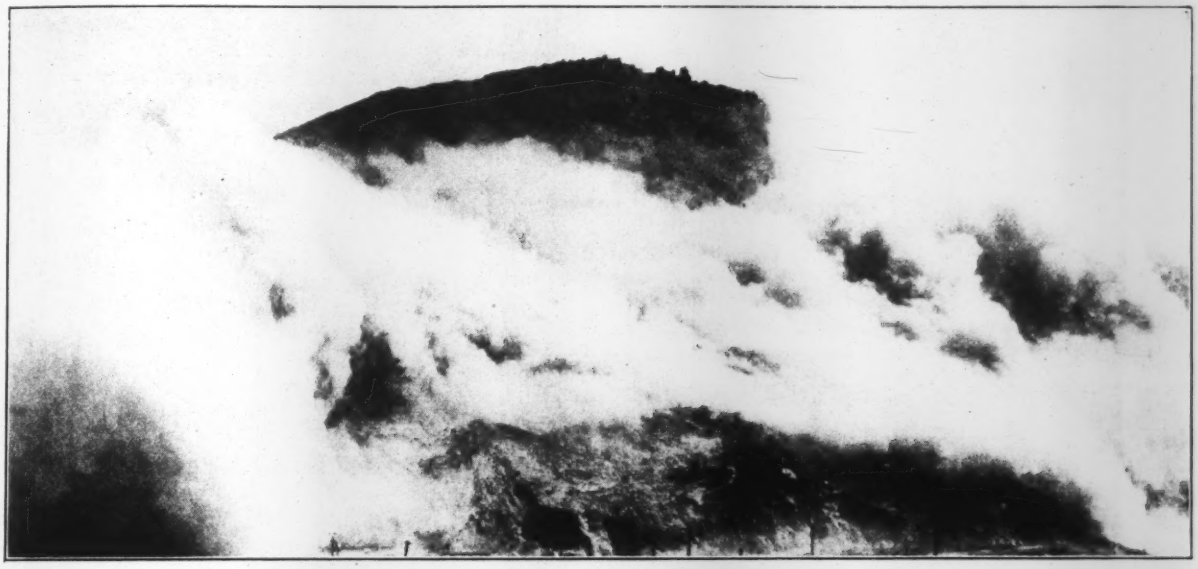

FIG. 4. VIEW FROM SAME POSITION AS FIG. 3 TAKEN A FEW SECONDS LATER

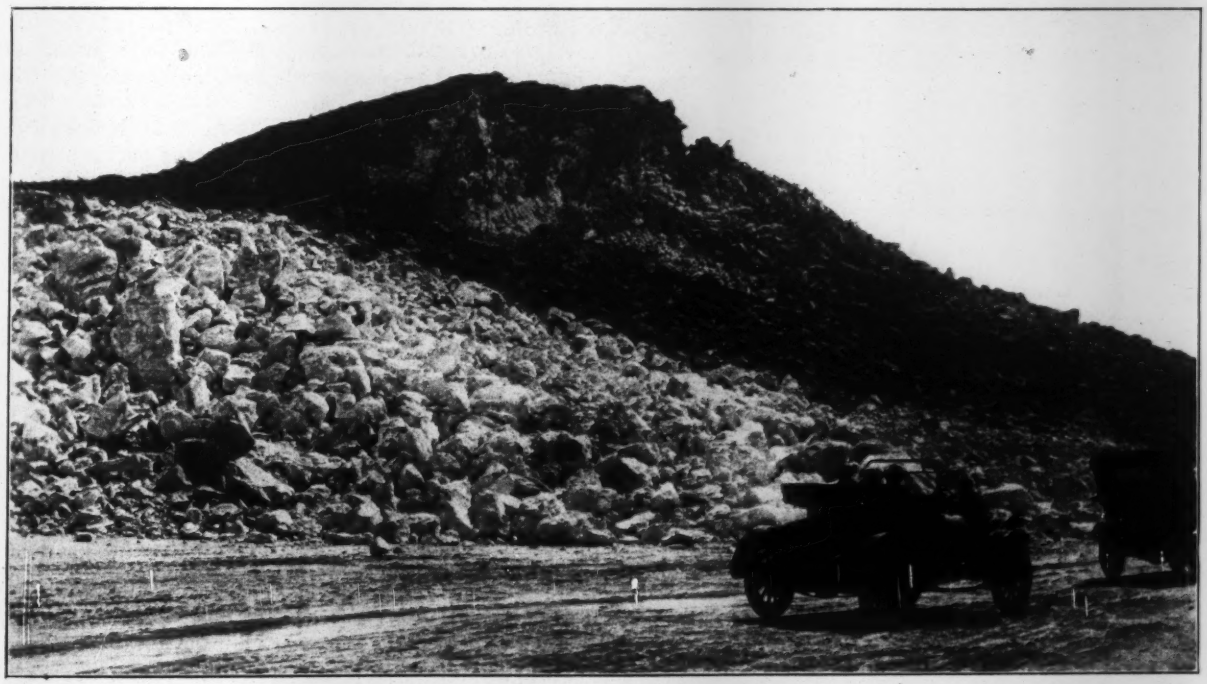

FIG. 5. VIEW OF ROCK THROWN DOWN BY BLAST

New System for Burning Powdered Coal in Metallurgical Furnaces

By C. F. Herington*

The burning of powdered coal long ago passed from the experimental stage to practical use, and the present question is how far its usefulness may be extended.

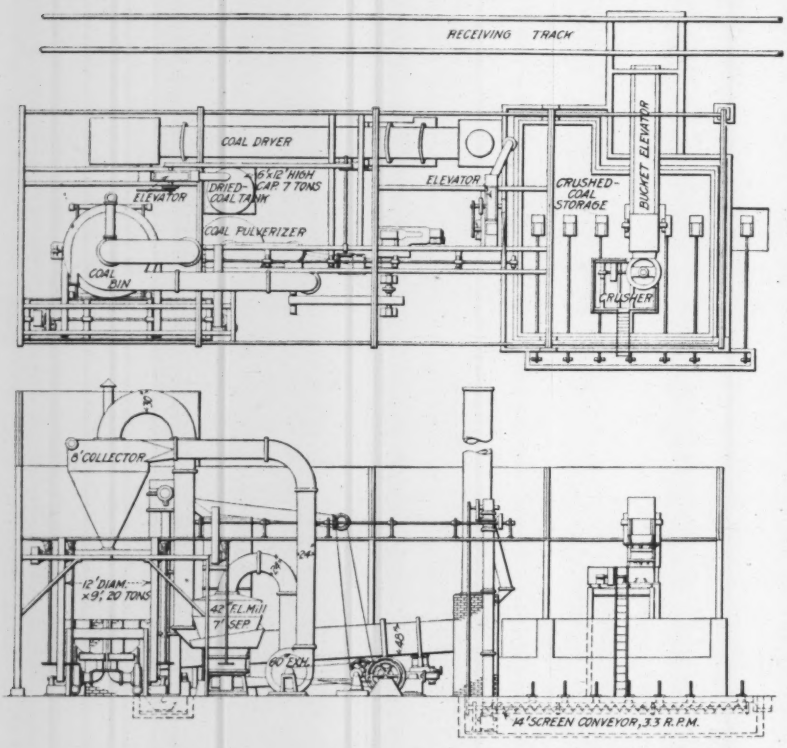

Fig. 1. General Layout of a Small Holbeck Plant for Burning Powdered Coal

It is well known that pulverized-coal fuel has been successfully used in the portland-cement industry for twenty years. But here the chief requisite, high temperature, is easily secured by simply blowing in the powdered coal mixed with the whole air supply. This scheme, however, is not well adapted to smaller furnaces for metallurgical work. The writer has seen practically every powdered-coal plant in the East and has concluded that none of them is working out successfully the problem of burning pulverized coal—with the exception of two plants which embody an altogether new system. These are unique and deserve description.

Continued failure has not daunted inventors, for pulverized coal has every intrinsic advantage in its favor—low cost per heat unit compared with other fuels, 100% efficiency of combustion compared with 70 to 80% in a gas producer, ease of control equal to gas or oil, and lack of volatility, with consequent diminished fire hazard.

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The chief reasons for the usual lack of success with powdered coal are not difficult to find. About 43 years ago William Sweet, of Dilworth, Porter & Co., was using a screw conveyor to inject powdered coal into his furnaces, and that primitive method is still in use. The coal crushers, driers, elevators and pulverizers have been improved; but the conveyor-and-feeder, which is by far the most expensive part of the whole installation in first cost and upkeep, has been neglected.

The new system, which the writer has had a chance to inspect in the course of certain studies of available powdered-coal systems, is a success because the inventor and designer, Austin A. Holbeck, of Cleveland, Ohio, has worked out a distributing and feeding system for conveying the coal to a number of furnaces in a new way—by air.

Fig. 1 shows a general plan of a pulverizing plant and distributing system supplying a small number of furnaces. There is no drier in this particular plant, since, with air separation and air distribution, a greater part of the moisture is taken out of the coal as it circulates through the pipes. (Omission of a drier is not necessarily new; for instance, the Universal Portland Cement Co., at Universal, Penn., does not dry its coal.) By eliminating the drier, the first cost of the installation can be cut down. However, the drier had better not be left out, except in small plants having a capacity of less than 2000 lb. per hr., until more experience is gained. In large plants there is marked economy in drying the coal before crushing.

The general scheme of the new method, as applied to the pulverizing machinery, is shown in Fig. 2. This plant is at Erie, Penn., and has a capacity of 3 to 5 tons of pulverized coal per hour. The coal is dumped from cars alongside the plant, is received by a bucket elevator, raised above the storage bin, dropped into a crusher and run into storage (holding 300 tons of crushed coal). Underneath this bin is a 14-in. screw conveyor having, at suitable intervals, gates opening into the bin and controlled by levers outside the building. The coal is carried to an inclosed elevator, which raises it and spouts it into the drier. After passing through the drier it is raised

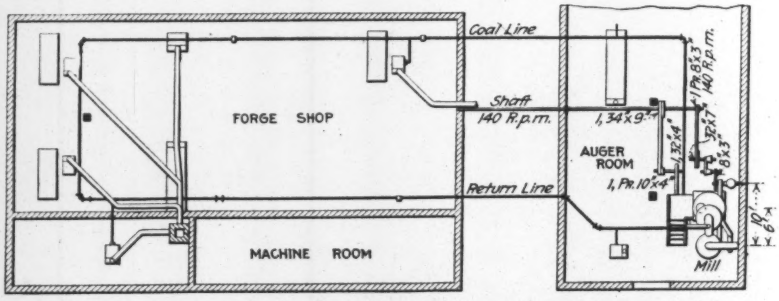

Fig. 2. Arrangement of Coal-Pulverizing Machinery, Holbeck System

to a dried-coal storage bin, whence it is carried by a short screw conveyor to the pulverizer mill. This mill has the screens removed and is connected through a specially designed separator to the suction end of an exhauster. The fine particles of coal are drawn out of the mill by the exhauster and discharged into a second separator, from which the fine particles drop into the pulverized-coal bin.

FIG. 3. FORGE FURNACE EQUIPPED FOR BURNING POWDERED COAL

The top of the second separator is connected back to the pulverizer mill, with a vent to the atmosphere, thereby creating a small vacuum in the separator. The coal drops from the storage bin into hoppers, is fed by an automatic governor into the suction end of a high-pressure blower, discharged through pipes, carried underground to the forge shop, and there distributed overhead through pipes to the several furnaces.

At each furnace a small branch with a valve is taken off (the supply is controlled from the floor by the operator, much as is gas or oil). After the furnaces are all passed, a booster is connected to the supply line, and a return line is carried back to the suction of the blower; any coal which was not used at the furnaces is returned into the circulating main to be used over again.

Naturally the heart of the distributing system is the automatic governor, which controls the quantities and proportions of coal and air in circulation. If a number of furnaces are taking a supply of coal from the circulating main and one or more is shut down (by closing the supply valve at the branch), then the governor will immediately adjust the coal and air to the quantities required for the furnaces remaining in operation. This feature was tested by the writer and found to be satisfactory.

The calorific value of the mixture of coal dust and air is just about equivalent to the same quantity of natural gas, and this mixture is kept in continuous circulation at a speed of several thousand feet per minute. While the air is in motion, the powdered coal cannot settle in the pipes; as there is only about 1 lb. of dust to about 12 cu.ft. of air, the amount of coal that could settle when circulation is stopped would not cover the bottom of the pipe.

The question of explosibility of the coal-air mixture is disposed of by considering that a mixture of 1 lb. of dust and about 150 cu.ft. of air is necessary for complete combustion, and that as the coal burden is increased below that proportion there is an increasing tendency to smother any incipient combustion. The air in the working stream is but one-sixtieth of that in a completely combustible mixture. Thus the system is brought very close to one furnishing gas or oil, so far as the ratio of combustible to oxygen is concerned.

This scheme of distributing coal dust is comparable in convenience with the handling of gas or oil fuel. But it has other advantages. The pulverizing plant does not need to be close to the forge shops. (In one of the present plants the pulverizer is at least 400 ft. away from the nearest furnace. No trouble is experienced in getting coal at the furnace, and the cost of power is much less than it would be if a screw conveyor was used.) The usual destructive effects on the brickwork of heating furnaces are eliminated. This would be expected, since the combustion chamber usually built at one end of the furnace is eliminated, and the furnace is erected with two small branches for the powdered coal leading to each end of the working chamber.

A second essential for successful burning of powdered coal is the removal of all smoke and as much ash as possible. How this is done with the new method is shown by Fig. 3. In front of each furnace the side walls are extended about 2 ft. and built up to the level of the work opening. On the top of these side walls a hood is placed across the entire front of the furnace, tapering upward to a small pipe. The pipe from each furnace is connected into a main line running to an exhauster at one end of the

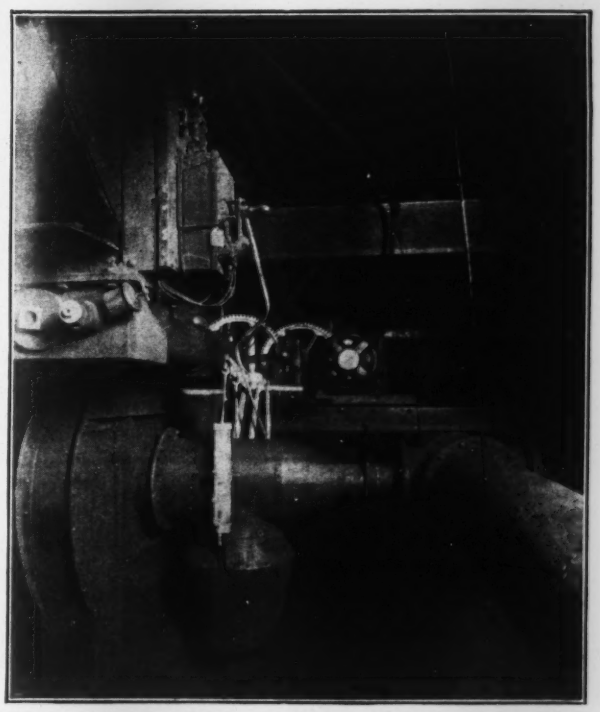

FIG. 4. GOVERNOR OF THE HOLBECK POWDERED-COAL DISTRIBUTING SYSTEM

shop; this fan draws out all the smoke and fine ash and discharges into a separator, at the bottom of which is a storage bin from which the cinders can be taken away and dumped. The larger particles of ash drop below the hood between the extended walls and are easily removed. The workmen are able to work nearer the powdered-coal furnace than one alongside which is burning fuel oil. The shop is free from smoke and ash. Fig. 3 shows a furnace with branch coming down, circulating main, valve handle, pipe for combustion-air supply, smoke exhaust, etc.

Fig. 4 shows the bottom hopper of the pulverized-coal bin and the screw feed (inclosed in a pipe), which drops the coal into the automatic governor, from which it is drawn into the suction end of the blower. This is driven by a constant-speed motor and runs all the time the shop is in operation. The small motor driving the screw feed is a variable-speed type and it is under the control of the governor. Starting up or shutting down furnaces changes the pressure in the circulating main; this affects the position of a diaphragm working through links to change the resistance of the motor field.

Garbage Reduction at Columbus, Ohio, 1913 and 1914

The following details of the operations of the municipally owned garbage-reduction works of Columbus, Ohio, are from an advance copy of the annual report for 1914 of T. D. Banks, Superintendent:

OPERATION OF MUNICIPAL REDUCTION PLANT, COLUMBUS, OHIO, 1913-14

Tons of Garbage Received

Month	1913	1914
January	1,508.13	1,504.06
February	1,209.95	1,112.20
March	1,198.57	1,402.81
April	1,771.22	1,552.73
May	1,709.61	1,627.12
June	1,614.76	1,817.47
July	2,021.22	2,095.81
August	2,216.44	2,263.93
September	2,324.95	2,614.47
October	1,995.77	2,283.42
November	1,551.42	1,740.77
December	1,588.70	1,616.18
Total for the year	20,710.74	21,628.97
Average per day for the year	72.16	69.32
Number of days plant operated	287	312
Estimated population	200,000	205,000
Pounds of garbage per capita	207	211
Number of large animals received	302	183

Actual Cost of Operation

Supervision	$3,982.00	$4,262.50
Firemen	2,498.24	2,670.03
Labor for repairs	2,491.42	2,190.27
Operators	3,912.45	4,760.79
Ordinary labor	11,572.19	10,600.53
Coal	6,864.16	6,777.01
Electric power	986.40	1,453.05
Gasoline	2,444.36	2,361.60
Maintenance supplies	1,064.27	981.66
Material for repairs	1,868.93	1,973.18
Renewals	523.91	792.09
Office expense	295.68	300.71
Analytical work	271.25	204.75
Transportation	553.65	709.88
Miscellaneous	232.34	182.73
Totals	$39,560.25	$40,220.78

Actual Cost of Operation per Ton of Garbage

Supervision	$0.192	$0.197
Firemen	0.121	0.123
Labor for repairs	0.120	0.101
Operators	0.189	0.220
Ordinary labor	0.559	0.490
Coal	0.331	0.313
Electric power	0.048	0.067
Gasoline	0.118	0.109
Maintenance supplies	0.052	0.045
Material for repairs	0.090	0.091
Renewals	0.025	0.037
Office expense	0.014	0.014
Analytical work	0.013	0.010
Transportation	0.027	0.033
Miscellaneous	0.011	0.009
Totals	$1.910	$1.859

Actual Production (Receipts Corrected from Inventories)

Grease, pounds	1,095,594	1,186,985
Tankage, tons	2,095	1,753
Hides, number	291	183
Grease value	$40,839.35	$52,672.21
Tankage value	14,223.31	12,987.84
Hides value	1,247.39	1,062.30
Miscellaneous	489.73	.....
Total	$56,799.78	$66,722.35
Grease per ton garbage, pounds	53.93	54.87
Tankage per ton garbage, pounds	202.30	162.10
Grease value per ton garbage	$1.97	$2.435
Tankage value per ton garbage	0.69	0.60
Hide values per ton garbage	0.06	0.05
Miscellaneous value per ton garbage	0.02	...
Total value of products per ton garbage	$2.74	$3.085
Profit per ton of garbage	$0.83	$1.226
Net profit	$17,239.53	$26,501.57

Because it is the best-paying single department of the plant, we give below a record of the operation of the percolator, or grease-extracting department. This department first started operation in January, 1912. The total cost of this part of the plant was $26,242.60, so it will be seen that it was a very good investment.

Percolator Operation

Number of charges	214	212
Grease recovered, tons	220	235
Grease recovered, value	$15,500.00	$20,154.50
Coal used, tons	700	700
Gasoline used, gallons	18,111	19,119
Cost of operation:		
Supervision	$497.75	$532.80
Labor	1,334.55	1,450.80
Coal	1,029.00	975.10
Gasoline	2,444.36	2,361.60
Repairs and supplies	200.00	150.00
Total cost	$5,505.66	$5,470.30
Revenue per ton of garbage	$0.748	$0.932
Cost of operation per ton of garbage	0.266	0.253
Profit per ton of garbage	0.482	0.679
Net profit	$9,994.34	$14,684.20

Coal, Electric Power and Gasoline Used per Ton of Garbage

Coal, tons	0.225	0.225
Electric power, kw.-hr.	5.17	4.48
Gasoline, gallons	0.874	0.884
Prices received for products:		
Grease, per 100 lb.	$3.75	$4.325
Tankage per unit of		
Ammonia	1.51	1.71
Potash	0.70	0.70
Tri-calcium-phosphate	0.10	0.10
Average price per ton of tankage	6.79	7.41

Average Analysis of Tankage

Moisture	8.0	3.1
Grease	1.8	1.2
Ammonia	3.56	3.58
Potash	0.99	0.78
Tri-calcium-phosphate	7.35	8.08

Average Analysis of Grease

Moisture	2.53	1.52
Impurities	0.125	0.131
Unsaponifiable	2.84	2.91

Percentages of Products Recovered from Garbage

Grease	2.64	2.74
Tankage	10.10	8.10
Total	12.74	10.84

A Sewerage System and Sewage-Disposal Farm at Cairo, Egypt, which has been under construction for the past half-dozen years, was put into operation in March. The principal features of the system are the use of compressed-air ejectors for forcing the sewage to a central pumping station and the final discharge of the sewage through a long outfall sewer a dozen miles in length to a sewage farm in the desert. The farm is about 3000 acres in extent and has been laid out to utilize the sewage discharged by a population of about three-quarters of a million. The use of the compressed-air ejector system is made necessary by the level ground on which Cairo stands. The central part of the city is divided in 63 districts, each of which drains to an ejector station that delivers the sewage through a force main to a principal collecting sewer. The compressed air for operating the ejectors is supplied from a central compressing station. The main pumping station, which forces the sewage through the long delivery main to the sewage farm, contains pumping machinery capable of delivering 50 cu.m. per min. against a head of 250 ft. The sewerage system is only partially completed, the work having been interrupted by the war. The chief engineer of the work is C. Carkeet James. Previous to his taking charge of the Cairo work in 1906, he was connected with the sewerage system of Bombay.

Flangeway Guards and Frog Guard-Rails

Two recent applications of malleable-iron castings in railway track are described below. They are the Newhall flangeway guards for highway crossings and track frogs, and are specialties of the Cleveland Railway Supply Co., of Cleveland, Ohio. They are already in use on several railways.

Flangeway Guard-Rail for Road Crossings

The combined guard-rail and flangeway guard for road and street crossings of railway tracks, shown in Fig. 1, is designed to protect the paving and the wheels of highway vehicles, while affording an effective flangeway

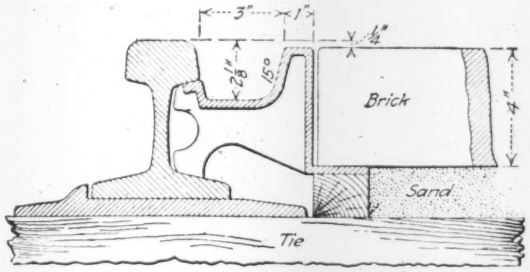

Fig. 1. Malleable-Iron Flangeway Guard for Road Crossings

for wheels of trains. It is of malleable iron, made in sections 4 ft. long, which weigh about 34 lb. each. The sections are locked together by means of lugs, and special end sections provide the usual flaring ends of the flangeway. These sections are fitted under the rail head, so that horseshoe calks cannot catch on the rail, and the edge lying against the paving is so shaped that it will not cut the tires of automobile wheels. The flangeway is deep; it is wide enough to clear railway wheels when the

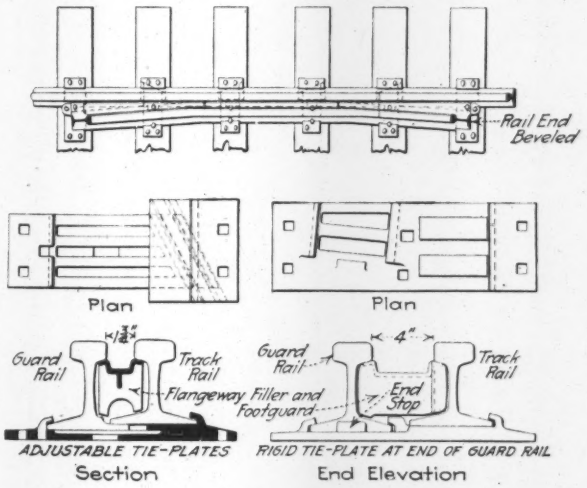

Fig. 2. Frog Guard-Rail with Adjustable Tie-Plates and Continuous Flangeway Filler

track gage is ½ in. wide, and the flaring outer side tends to make it self-cleaning.

The illustration shows the guard as applied with brick paving, but it is used also with the ordinary crossing planks, filler timbers on the ties giving the necessary elevation. No fastenings are required, the guard being held in place by the rail and the paving.

Frog Guard-Rail Construction

Malleable castings similar to those described above are used also to form foot guards and continuous flangeway fillers at frog guard-rails, although the general practice is to leave the flangeway open except for the foot guards at the ends. These castings are 3 ft. long, and the construction for 9-ft. guard-rails is shown in Fig. 2. For main-track frogs 12-ft. rails may be used. The guard-rail has its flange planed to form a support for the track rail, so that lateral or overturning stress exerted against the former is resisted by the load upon the latter rail. The ends of the guard-rail are cut to a slope of 45° so as not to catch hanging chains or brake rigging.

The special forms of tie-plates for carrying the track rail and guard-rail are shown also in Fig. 2. Each end tie-plate is a single piece, with lugs for both rails and with an end stop to prevent creeping of the guard-rail. Each of the inner plates consists of two parts fitted together with dovetailed ribs which are diagonal to the rails. This provides for maintaining and adjusting the width of flangeway by shifting the upper plate along the lower, or fixed plate.

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Stresses in a Rigid Frame of Two Columns and a Truss

By Felix Freyhold*

Engineering News of Jan. 1, 1914, p. 44, published an editorial on "The Structural Engineer and the Orpheum Theater Failure," which states, among other things:

> Steelwork design is so precise and definite, especially in the case of buildings, that the story of a failure is rather disconcerting reading. The engineer justly feels certain of his data, in building matters; so that possessing clear and direct methods of computation and knowing the object of design is free from disturbing incidentals such as impact he relies on the result with perfect assurance. What then if a frame collapses when still new, or even before being put in service, like that of the Orpheum Theater in New York? It is necessary to look into the circumstances very closely, and single out the elements of trouble for future guidance. . . .
>
> The Orpheum collapse exhibits more graphically than any previous case known to us the close interrelation of strength and elastic nature in most structures, even in such as are strictly "simple" (in the limited present-day meaning of the term).

In this structure were two most important frames, each consisting of two columns bolted to concrete piers and having a connecting truss riveted to their upper ends for the purpose of supporting other parts of the building. Such a frame is not a "simple" structure (in the limited present-day meaning of the term) but is a statically indeterminate structure similar to an elastic arch. Stresses in such a structure can be found only by applying to the analysis the principles of the elastic theory. In the investigations held after the collapse, as far as the writer knows no such analysis was made along these lines to determine the probable cause of the failure of the frames. In the analysis of stresses in such frames most text-books fail to call attention to the large bending moments in the columns and the effect on the truss members caused by the thrust due to the roof loads and the changes in temperature above or below that at which the structure was erected.

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COMPARISON OF STRESSES FOR VARIOUS CONDITIONS CONSIDERED

		Roof Load Stresses			Crane Thrust Stresses				Temperature Stresses Rise or Fall of 50° F.		Total Maximum Stresses				
		Cols. Fixed at Base By Least Work	Cols. Hinged at Base. By Least Work	Truss Simply Resting on Columns. Method Used	Col. Fixed at Base. By Least Work	Cols. Hinged at Base. By Least Work	Cols. Fixed at Base. Method Used	Cols. Hinged at Base. Method Used	Cols. Fixed at Base	Cols. Hinged at Base	Method Used	Cols. Fixed at Base. By Least Work	Cols. Hinged at Base. By Least Work	Cols. Fixed at Base. Method Used	Cols. Hinged at Base. Method Used
Upper Chord	BF	+1,500	+1,500	+1,500	+00,000	00,000	00,000	00,000	±00,000	00,000		+1,500	+1,500	1,500	+1,500
	BH	+33,000	+13,000	+9,400	+29,000	+17,000	+5,900	+20,900	±35,000	±10,500		−2,000 +97,000 −22,000 +72,500	+41,500	+15,000 −11,000	−27,000 +30,000
	BJ	+9,000	−10,000	−22,400	+32,500	+10,500	+2,800	+13,200	±31,000	±11,000			−43,000	−28,000	−49,000
	BL	−16,000	−31,000	−43,700	+26,000	−5,000	−1,500	+6,000	±27,500	±9,000		−43,500	−55,000	−55,000	−62,000
	BN	−18,000	−40,000	−52,600	+21,000	0,000	−2,500	−600	±24,000	±8,000		−42,000	−57,000	−61,000	−65,000
	BP	−29,000	−38,000	−51,300	+17,000	−4,000	−4,400	−4,800	±21,000	±5,000		−50,000	−53,000	−56,000	−56,000
	BR	−18,000	−40,000	−54,000	+14,000	−9,000	−7,400	−10,700	±24,000	±8,000		−42,000	−57,000	−61,000	−65,000
	BT	−16,000	−31,000	−43,700	+11,000	−15,000	−11,200	−18,000	±27,500	±9,000		−43,500	−55,000	−55,000	−62,000
	BV	+9,000	−10,000	−22,400	+8,000	−22,000	−15,800	−27,000	±31,000	±11,000		−22,000 +72,500 −2,000 +97,000	−43,000	−28,000 −11,000	−49,000 −27,000 +30,000
	BX	+33,000	+13,000	+9,400	+5,000	−40,000	−20,700	−36,300	±35,000	±10,500			+41,000		
	BZ	+1,500	+1,500	+1,500	00,000	00,000	00,000	00,000	00,000	00,000		+1,500	+1,500	+1,500	+1,500
Lower Chord	EG	−27,000	−1,200	−3,700	−24,000	−4,000	−5,500	−19,500	∓ 25,000	∓ 7,000		−76,000	−18,000	+16,000 −9,000	+30,000 −23,000
	AI	−29,000	−4,000	+9,400	−39,000	−15,000	−1,200	−13,700	∓ 40,000	∓ 11,000		−108,000	−30,000	+32,000	+30,100
	AK	+1,200	+22,000	+36,000	−33,000	−9,000	+1,800	−6,300	∓ 36,000	∓ 10,000		−68,000	+48,000	+52,000	+61,000
	AM	+19,000	+37,000	+50,500	−27,000	−4,000	+4,400	+2,500	∓ 32,500	∓ 9,000		−40,000 +51,000	+56,000	+62,000	+67,000
	AO	+25,000	+40,000	+54,000	−23,000	0,000	+6,500	+6,000	∓ 29,000	∓ 8,000		−52,000 +54,000	+62,000	+61,000	+63,000
	AQ	+25,000	+40,000	+54,000	−19,000	+4,500	+8,800	+10,600	∓ 29,000	∓ 8,000		−52,000 +54,000	+62,000	+63,000	+63,000
	AS	+19,000	+37,000	+50,000	−16,000	+10,000	+12,200	+17,200	∓ 32,500	∓ 9,000		−40,000 +51,000	+56,000	+62,000	+67,000
	AU	+1,200	+22,000	+36,000	−14,000	+16,000	+16,300	+25,200	∓ 36,000	∓ 10,000		−68,000	+48,000	+52,000	+61,000
	AW	−29,000	−4,000	+9,400	−11,000	+24,500	+21,100	+34,400	∓ 40,000	∓ 11,000		−108,000	+30,000	+32,000	+30,100
	aY	27,000	−1,200	−3,700	−6,000	+12,000	+19,400	+33,300	∓ 25,000	∓ 7,000		−76,000	+18,000	+16,000 −9,000	+30,000 −23,000
Kneebrace	BE	+9,000	+2,000		+6,000	+2,500	+3,700	+13,000	±11,000	±2,000		−2,000 +26,000	+6,500	+4,000	+13,000
	BF	−2,800	−2,500	−2,400	00,000	00,000	00,000	00,000	00,000	00,000		−2,800	−2,500	−2,400	−2,400
	FG	+27,000	+12,000	+2,900	+28,000	+12,000	+4,250	+15,000	±25,000	±8,000		+80,000	+18,000	−17,000 +7,200	−28,000 +18,000
	CH	−30,000	−15,000	−7,700	−25,000	−14,000	−3,650	−13,000	∓ 23,000	∓ 7,000		−78,000	−36,000	+16,000 −11,400	+25,000 −21,000
	HI	−30,000	−27,000	−27,400	−5,000	−5,000	−2,360	−5,900	∓ 3,000	∓ 800		−38,000	−33,000	−29,800	−33,000
	IJ	+21,000	+18,000	+18,600	+4,500	+4,500	+2,100	+5,200	±3,000	±800		+28,500	+23,000	+30,000 −31,000	−34,000 +24,000
	JK	−22,000	−19,000	−19,200	−5,000	−4,000	−2,200	−5,400	∓ 3,000	∓ 800		−30,000	−24,000	−21,000 +22,000	∓ 25,000
	KL	+13,000	+10,500	+10,500	+4,000	+3,000	+1,900	+4,700	±2,500	±800		+19,500	+14,000	+12,000 −22,000	−25,000 +15,000
	LM	−13,000	−10,000	−10,200	−4,000	−4,000	−1,900	−4,600	∓ 2,500	∓ 800		−19,500	−15,000	−12,000 +14,000	−15,000
	MN	+5,000	+2,500	+2,500	+4,000	+3,000	+1,600	+4,100	±2,000	±500		+11,000	+6,000	+4,000 −13,000	+7,000
	NO	−5,000	−2,000	−2,500	−3,000	−3,000	−1,500	−3,900	∓ 2,000	∓ 500		−10,000	−6,000	−4,000 +5,000	−7,000
	OP	−3,000	+4,500	+4,200	+3,000	+2,500	+1,400	−3,500	±2,000	±500		−8,000	+8,000	+6,000	+4,000
	FQ	−3,000	−4,500	−4,200	−3,000	−2,500	−2,200	−4,300	∓ 2,000	±500		−8,000	+8,000	+5,000	−7,000
	OR	−5,000	+2,000	+2,500	+2,000	+4,000	+2,400	+4,700	∓ 2,000	±500		−10,000	−6,000	+5,000	+7,000
	RS	−5,000	−2,500	−2,500	−2,000	−4,000	−2,600	−5,000	∓ 2,000	±500		+11 000	+6,000	+4,000 −13,000	−15,000
	ST	−13,000	+10,000	+10,200	+2,000	+5,000	+3,000	+5,600	∓ 2,500	±800		−19,500	−15,000	−12,000 +14,000	−15,000 +16,000
	TU	+13,000	−10,500	−10,500	−2,000	−5,000	−3,000	−5,900	∓ 2,500	±800		+19,500	+14,000	+12,000 −22,000	+15,000 −25,000
	UV	−22,000	+19,000	+19,200	+2,000	+5,000	+3,500	+6,600	±3,000	±800		−30,000	−24,000	−21,000 +22,000	∓ 25,000
	VW	+21,000	−18,000	−18,600	−2,000	−5,000	−3,300	−6,300	∓ 3,000	±800		+28,500	+23,000	+30,000 −31,000	+24,000 −34,000
	WX	−30,000	−27,000	−27,400	+2,000	+6,000	+3,800	+7,100	∓ 3,000	±800		−38,000	−33,000	−29,800	−33,000
	Xy	−30,000	+15,000	+7,700	−4,000	+28,000	+12,800	+22,500	∓ 23,000	±7,000		−78,000	−36,000	+16,000 −11,400	−21,000 +25,000
	YZ	+27,000	−12,000	−2,900	+4,000	−22,000	−14,800	−25,800	25,000	±8,000		+80,000	+18,000	−17,000 +7,200	−28,000 +18,000
	BZ	−2,800	−2,500	−2,400	00,000	00,000	00,000	00,000	00,000	00,000		−2,800	−2,500	−2,400	−2,400
Moment at A		+1,016,000	000,000	0,000,000	−66,000	000,000	−1,182,000	0,000,000	±1,395,000	000,000		−3,477,000	0,000,000	−1,182,000	0,000,000
Moment at A′		−791,000	−423,000	0,000,000	−1,250,000	−498,000	+687,000	−935,000	∓785,500	±327,000		−2,826,000	2,121,000	+687,000	−935,000
Moment at B′		−791,000	−423,000	0,000,000	−381,000	−1,371,000	+687,000	−935,000	±386,000	±327,000		−2,826,000	−2,121,000	+687,000	−935,000
Moment at B		+1,016,000	000,000	0,000,000	−1,066,000	000,000	−1,182,000	0,000,000	±1,395,000	000,000		−3,477,000	0,000,000	−1,182,000	0,000,000

No. Temperature Stresses Considered

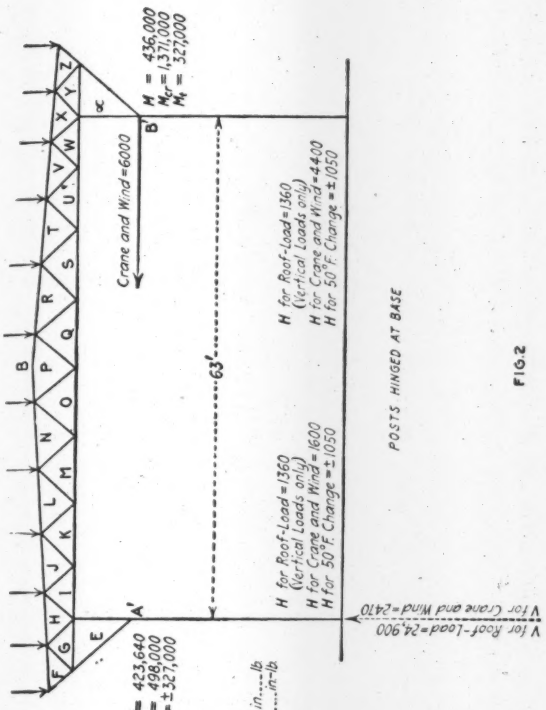

M = 436,000
Mcr = 1,371,000
Mt = 327,000
Crane and Wind = 6000
63'
H for Roof-Load = 1360 (Vertical Loads only)
H for Crane and Wind = 4400
H for 50° F. Change = ± 1050
POSTS HINGED AT BASE
V for Roof-Load = 24,900
V for Crane and Wind = 2410
M = 423,640
Mcr = 498,000
Mt = ±327,000
Forces & Loads in.....lb
Moments in.....in-lb

FIG. 2

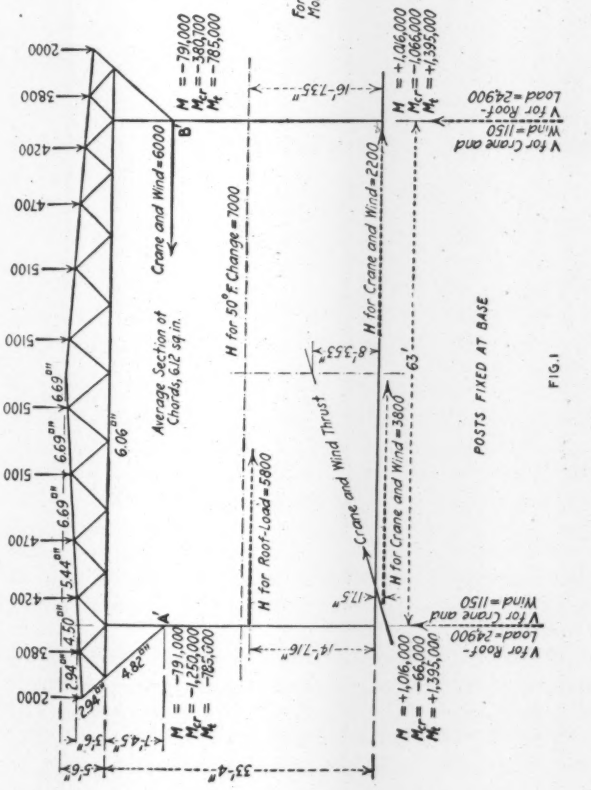

M = −791,000
Mcr = −384,700
Mt = −785,000
M = +1,046,000
Mcr = −1,066,000
Mt = +1,395,000
V for Crane and Wind = 1150
V for Roof-Load = 24,900
Crane and Wind = 6000
H for 50° F. Change = 7000
H for Crane and Wind = 2200
Average Section of Chords, 6.12 sq. in.
H for Roof-Load = 5800
Crane and Wind Thrust
H for Crane and Wind = 3800
63'
POSTS FIXED AT BASE
M = −791,000
Mcr = −1,250,000
Mt = −785,000
M = +1,046,000
Mcr = −66,000
Mt = +1,395,000
V for Crane and Wind = 1150
V for Roof-Load = 24,900
33'-4"

FIG. 1

In order to help form a judgment as to the differences in results obtained by the usual methods of analysis and those obtained by analyzing a frame, *first* (Fig. 1) as an elastic structure with columns fixed at the base; *second* (Fig. 2) as an elastic structure with columns hinged at the base, the frame shown in Figs. 1 and 2 was used. The structure was designed by another engineer; the stresses found by him in accordance with the usual methods of analysis are tabulated in the accompanying table with those found by the methods of least work. In Fig. 1 is shown the thrust line found due to the horizontal force of 6000 lb. acting on the right side of the building, determined according to the elastic theory. In this drawing are also shown the thrust due to the vertical roof loads (i.e. thrust arising from the deflection of truss and columns under the loads), and thrust due to a 50° F. rise.

In the actual designing of the structure the thrust due to the horizontal force of 6000 lb. was assumed as horizontal in direction and acting 16 ft. 5 in. above the base of column, and no thrusts due to vertical loads and changes in temperature were considered.

The location of the thrust (point of contraflexure) for columns fixed at the base is generally found under the common assumption that under the action of the horizontal force the horizontal deflection of the column where it joins the lower chord of the roof truss is the same in amount as the deflection of the column at the point where the kneebrace joins the column. This supposition may be true in some special design, but in actual cases generally is not so. The horizontal deflections at these two points can easily be found from the sectional areas of, and the stresses in, the members as given. In the case under consideration the supposition does not hold true. The thrust due to horizontal forces is generally arbitrarily assumed as horizontal, and equal in amount to the horizontal force, which generally is not true. The case illustrated shows the amount and direction of the thrust due to horizontal force, as found through elastic analysis by the method of least work.

In looking at the table showing comparison of stresses for various cases considered we see that, in the case of columns fixed at the base, the *temperature stresses* play as important a part in the chords and in some web members as the stresses due to roof loads or horizontal force. With columns hinged at the base, temperature stresses are of considerably less importance, and the maximum moment in the column is very much less than for columns fixed at the base. Therefore, if it were only a question of saving weight we would have hinges at the foot of all columns; however, other considerations generally enter into the question which make this undesirable. Columns are generally fixed to their piers, more or less, by foundation bolts. Thus, in all cases of frames with the exception of those having perfect hinged bases, there is always some degree of fixity, which will tend to cause increased stresses; therefore, *for safety the frames should be computed as absolutely fixed at the base.*

Comparing generally the results obtained by least work with those obtained by the usual method of calculation we find that the maximum possible moments in the columns obtained by the first method are nearly three times those obtained by the second; chord and web members toward the ends of the truss are larger for the first method than the second, while the reverse is true for the members near the middle of the truss.

Field and Office

Lifting One Truss of a Bridge to Place Larger Shoe

By W. R. Browne*

The addition of new reinforcing trusses on the downstream side of the New York State Barge Canal bridge at Dam 5, near Rotterdam Junction, N. Y., necessitated jacking up the old trusses to permit the placing of new bearing plates and shoes which would accommodate both the old and new trusses. The bridge is a three-span struc-

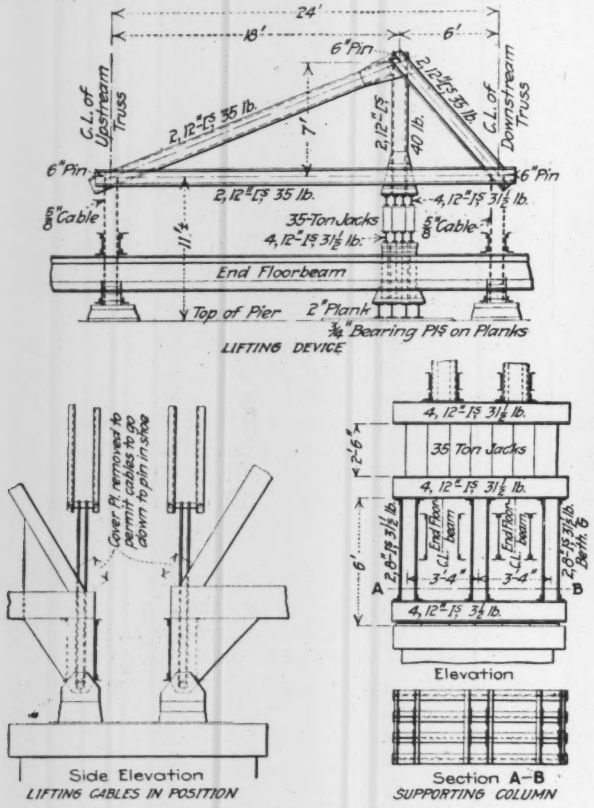


Fig. 1. Lifting-Truss for Raising Downstream Truss of Dam Bridge

ture carrying no roadway but supporting a movable dam hung from the floor-beams. The reinforcing provides for a highway and also strengthens the dam. The two end spans are 156½ ft. each, while the middle span measures 216½ ft. Several plans for raising these trusses were submitted to the authorities at Albany, but the method accepted and successfully used is presented herewith.

The lifting device consisted of a triangular truss, each member of which was made up of two latticed 12-in. 35-lb. channels spaced 12⅞ in. and connected with 6-in. pins. The pins in the lower chord were spaced 24 ft. on centers, but pin-holes in the chord and adjoining inclined member will permit shortening the span to 22 ft. or 20 ft. to fit narrower bridges on which similar work is to be done. The inclined members measured respectively 19 ft. 3¾ in. and 9 ft. 2⅝ in.; thus, when the end pins were centered over the truss pins the connecting pin of these inclined members was but 6 ft. from the line of the downstream truss. A supporting column (see sketch) was built up, passing between the channels of the lower chord and engaging this pin.

The end pins of the lifting device were centered over the truss pins and connected thereto by about 20 parts of extra-pliable ⅝-in. wire rope (tested ultimate strength, 16 tons). The actual lifting power was furnished by 35-ton Norton jacks placed between two plate-covered I-beam grillages in the supporting column, as shown in the sketches. In lifting the shore ends of the outside spans 6 jacks were used with one triangular lifting device; in this case but two columns were used in the support.

Fig. 2. Lifting-Truss in Place for Elevating One End of 156½-Ft. Span

At the intermediate piers 8 jacks were used, and three columns supported two jacking devices, one over the pins of each span. The two trusses when used together were braced laterally by lacing and struts; when one span alone was lifted it was necessary to guy the lifting device, the guys being adjusted by steamboat ratchets.

It required nearly a day to erect this device, but the actual jacking and changing of bearing plates and shoes took about an hour. At the shore ends of the outside spans the truss was assembled on the bridge floor and erected as a unit, but at the intermediate piers limited space compelled connecting the truss as it was raised. A light gin-pole proved very satisfactory in handling the truss and column members.

The load (for downstream truss only) for the 216½-ft. span was 162,000 lb.; for the 156½-ft. span, 104,000 lb. The jacks, however, had to exert lifts of 216,000 lb. and 138,000 lb. The column reaction will never exceed 223,000 lb. for any bridge on which this apparatus may be used. Since a bearing surface of 3360 sq.in. is used, the compression on the piers will never exceed 66½ lb. per sq.in.

*9 Pearl St., Amsterdam, N. Y.

Whitehead & Kales Iron Works, of Detroit, has the contract for reinforcing seven bridges of this type on the Barge Canal. The work is being done under the supervision of Mr. Andrews, Field Superintendent, and W. A. Keough, Foreman.

Elastic Yield of Rock Foundation of a Bridge Pier

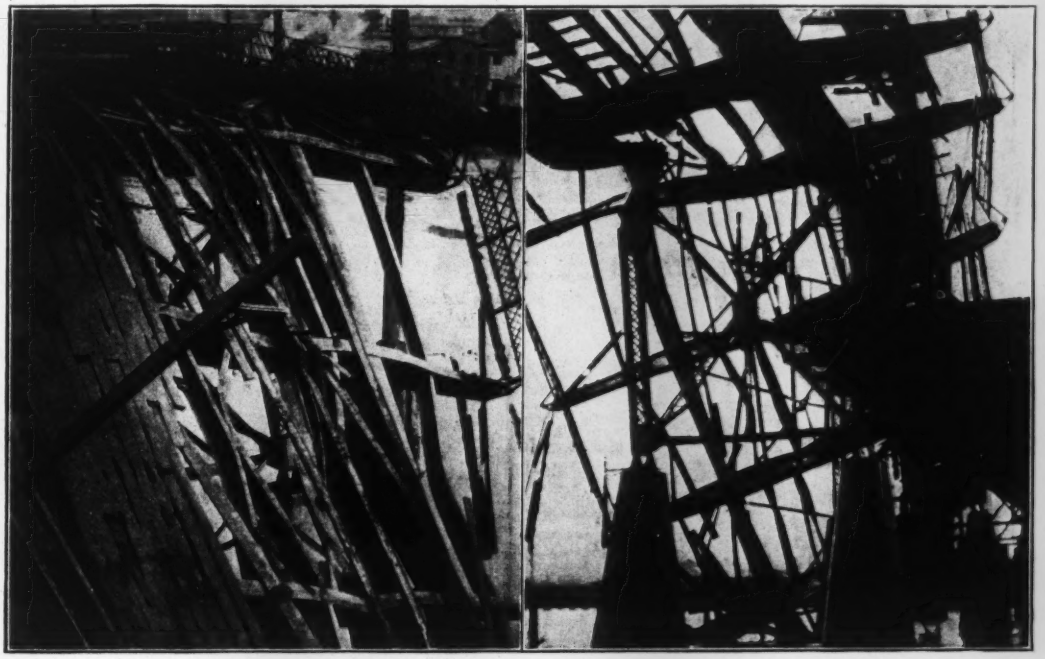
A bridge pier settled several inches recently during the completion of a railway bridge over the Potomac River, on what is now known as the Williamsport and Nessie line near Charlton, Md. Girders had just been placed from pier 5 to pier 6 and from 6 to 7, and a girder which was to span between 7 and 8 was being moved over pier 6 when it was noticed that this pier had settled about 4 in. on one side. When the load was backed off, the pier straightened. The next day a locomotive was run out on the pier, which then settled about ¾ in. Upon the removal of the load the pier returned to plumb. The water at pier 6 is about 4 ft. deep, and there is evidence of mud having been squeezed out from under the pier. The foundations are on rock, so it appears that the mud must come from a mud seam in the rock. The Potomac River in this vicinity is underlaid with a seamy sandstone.

The piers for this structure were completed about three years ago. The bridge is on a branch line from the Western Maryland R.R. leading to a stone quarry. On the completion of the piers and the delivery of the girders the property owners on the West Virginia side of the river got out an injunction and tied up this line until recently. The Pennsylvania Steel Co. is now erecting the steel superstructure. The ten piers and two abutments are designed for a single track. They are about 50 ft. high, the spans being 100 ft. The girders weigh about 35 tons each.

Expansion-Joint Action in Connaught Bridge Fire

Concerning the creosoted-floor fire that wrecked the Connaught Bridge over False Creek, Vancouver, B. C., on Apr. 29, as reported in our issue of May 13, 1915, p. 955, an additional feature is brought out by A. P. Hueckel, World Building, Vancouver. He says that the collapse of an 80-ft. plate-girder span (the viaduct consisted mainly of 40-ft. tower spans and 80-ft. intermediate spans) was due to the pulling out of an expansion joint, this in its turn being caused by distortions of the steelwork.

The previous account stated that the heat caused the span to collapse. This might be taken to mean that the girders sagged in the middle until they pulled clear of an end support. But the wreckage shows that both girders of the span are not sagged, but are fairly straight except close to the fixed end. At the fixed end the girders are buckled in the bottom flange, showing that a cantilever bending moment acted here. One girder is buckled just in front of the fixed-end floor-beam, the other *back* of the floor-beam, that is, in the adjoining span.



COLLAPSED SPAN OF THE CONNAUGHT BRIDGE

View from above shows that the fallen girder is straight, the girder in the tower span back of it being twisted by compressive buckling of its bottom flange. The same girder is seen in the left part of the view from below; the right girder in this view is buckled on the other side of the floorbeam, at the fixed end of the fallen span.

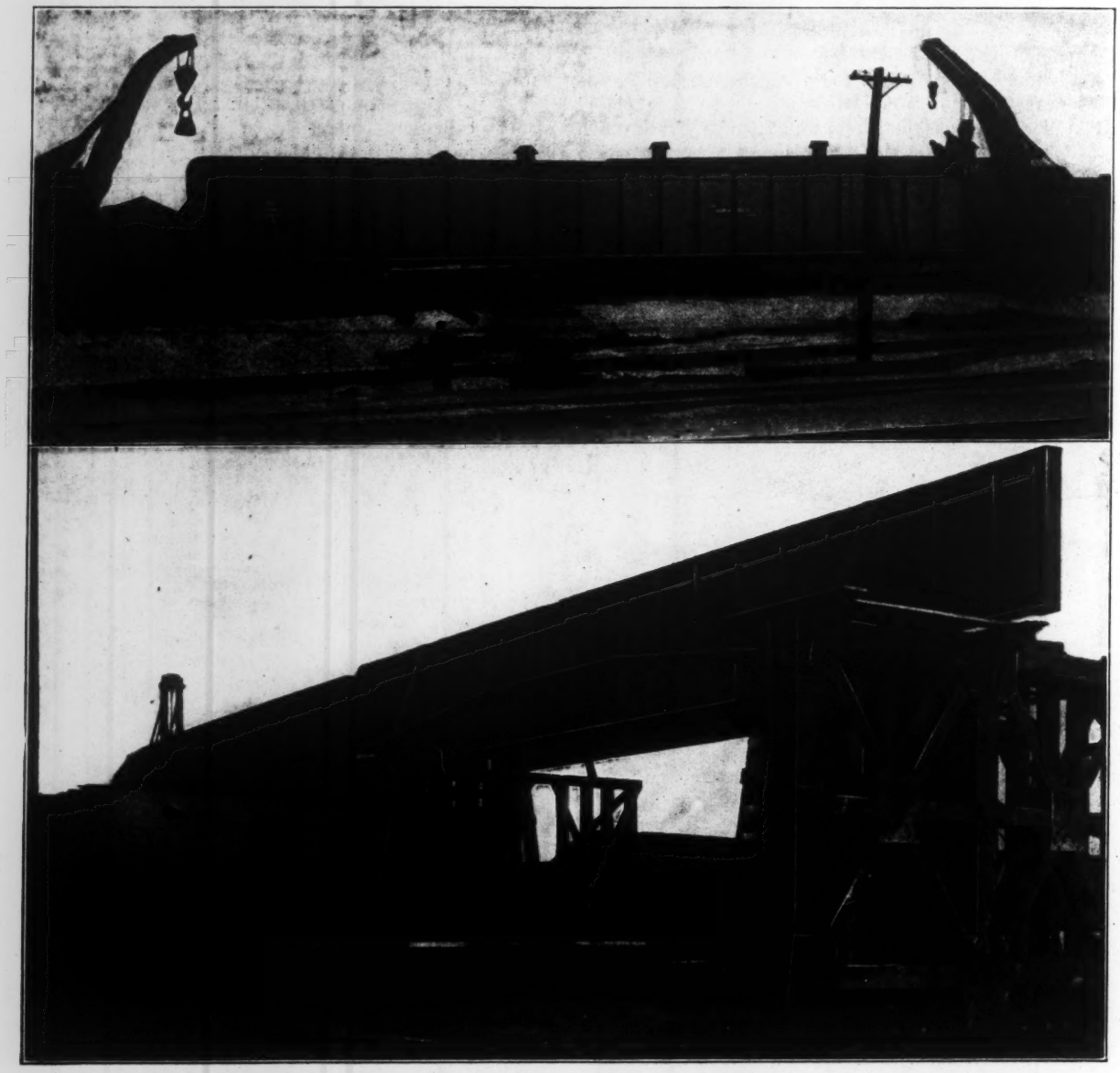
The appearance of these parts proves that the 80-ft. span fell because it lost its support at one end; this was the expansion end, which must have pulled out of the expansion pockets. Some secondary action subsequent to the heat expansion probably came into action to produce this effect.

Loading Platforms Inside Buildings—An interior loading platform, to prevent street obstruction by trucks or freight, will be a novel feature of the building soon to be erected for the Eagle Pencil Co. in New York City. With the exception of the main entrance hall and an inclosed storage space, the entire first floor will be utilized as a loading platform and driveway, allowing convenient movement of trucks. The platform will be accessible from two streets. The architects are Buchman & Fox.

Heavy Plate-Girders in Track-Elevation Work

Extensive grade-crossing elimination work has been in progress on the Buffalo division of the Delaware, Lackawanna & Western R.R. since the summer of 1913 where its two main tracks cross five tracks of the Buffalo Creek R.R., two of the Pennsylvania R.R. (Chautauqua division), and two of the New York, Chicago & St. Louis Ry., at Buffalo, N. Y. This work required the elevation of the D., L. & W. tracks and of the interchange yard, where both passengers and freight are interchanged with the Nickel Plate and the Lake Shore railways.

Raising the main-line track compelled tne construction of a new bridge over the Buffalo River and another over the railways mentioned and over a private driveway to the Contact Process Co. River improvements by the city required the use of a bascule span for the river crossing. The spans over the railways and the driveway comprise two through plate-girder spans, each 106 ft. long c. to c. and one deck plate-girder span of 30 ft. The floor will be of reinforced-concrete. The lower flanges of the girders over the railways will be incased in concrete.



HANDLING HEAVY PLATE-GIRDERS ON BUFFALO DIVISION, D. L. & W. R.R.
Unloading a 106-ft. girder on filling trestle (upper view), from which girder was skidded to place of erection 700 ft. distant (lower view)

The girders carrying the main tracks over the cross lines are unusually heavy, and in erecting great care had to be exercised to make certain that no delay to traffic occurred on the cross lines, where movements averaged about 10 per hour Light temporary girders were lifted by bridge derricks onto heavy framed bents erected to clear the outside tracks under each span. On these temporary girders the permanent girders were skidded to place longitudinally.

The permanent girders were unloaded from cars onto a temporary filling trestle near Smith St. by means of two locomotive cranes, one on each end of the girder (Fig. 1). From here they were run up and out on the temporary girders to place (Fig. 2). The steel bent for supporting the spans had already been erected.

Originally, Smith St. was crossed on two single-track through plate-girder spans. These girders were designed for use as deck spans as well, and they are now employed in that capacity on the new crossing at this street.

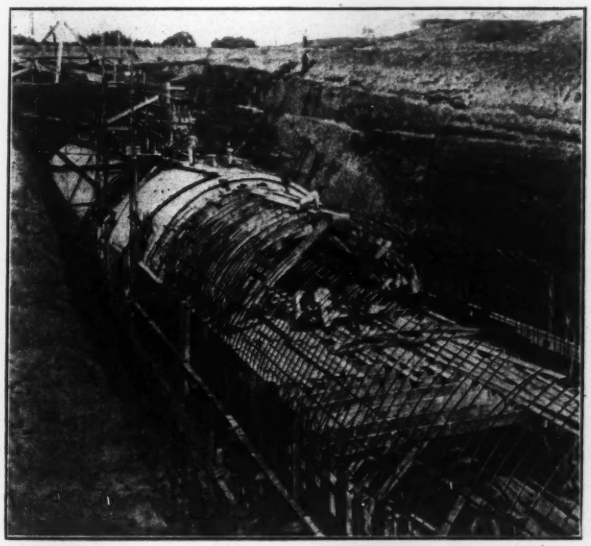
At the interchange yard with the present layout, three tracks cross Smith St. at grade, and these are raised to give 15 ft. clearance above the street. The spans carrying these tracks are composed of through plate-girders with open floor, but designed so that a reinforced-concrete slab floor can be laid should the city require it later.

For the present the bridges are carried on pile bents, it being uncertain whether the yard will be permanently maintained at this location.

The work is proceeding under the direction of G. J. Ray, Chief Engineer of the Delaware, Lackawanna & Western R.R.; A. E. Deal, Bridge Engineer; G. E. Boyd, Division Engineer. The steelwork is furnished by the American Bridge Co. and erected by the railway company.

Construction Work on Twin Peaks Tunnel, San Francisco

The accompanying view shows a very recent stage in the construction of the Twin Peaks Tunnel in San Francisco, described in ENGINEERING NEWS, Feb. 18, 1915, p. 315. The work shown is part of the 500-ft. opencut



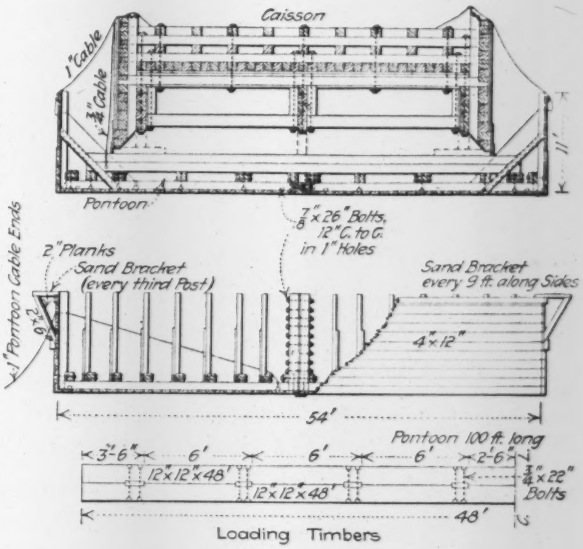
WORK AT WEST PORTAL, TWIN PEAKS TUNNEL

at the west portal. The trench here was excavated to a depth of 6 ft. with fresno scrapers and carried down to grade with steam shovels. Concrete is chuted into place from a batch mixer on the adjacent bank.

No work has as yet been done in tunneling operations, but the open-cut excavation at both portals is progressing satisfactorily.

Pontoon for Building Memphis Bridge Caissons

The caissons for the piers of the new Memphis cantilever bridge were built in a pontoon and were launched by separating the pontoon into halves (after flooding it) and then pulling out the halves from under the caisson. In order to carry out this procedure, the 54x100-ft. pontoon was built in halves connected along the longitudinal



CAISSON-LAUNCHING PONTOON, MEMPHIS BRIDGE

center line by a bolted joint. The contact surfaces of the halves were 12x12 edging sticks; and ¾-in. and ⅞-in. bolts held them together. Tar paper was placed in the joint to make it tight.

The floorbeams of the pontoon were 12x12 timbers spaced 3 ft. The sides, 11 ft. high, were braced to the floorbeams by 6x6-in. kneebraces.

The accompanying drawing, furnished us through the courtesy of the contractor (Union Bridge & Construction Co., Kansas City, Mo.) and the Resident Engineer (M. B. Case), shows in some detail the construction of the pontoon and the arrangement of transverse girders made of two 12x12's notched together as loading beams to distribute the caisson weight over the bottom of the pontoon.

Cost of Asphaltic Concrete Pavement with Small Portable Mixer

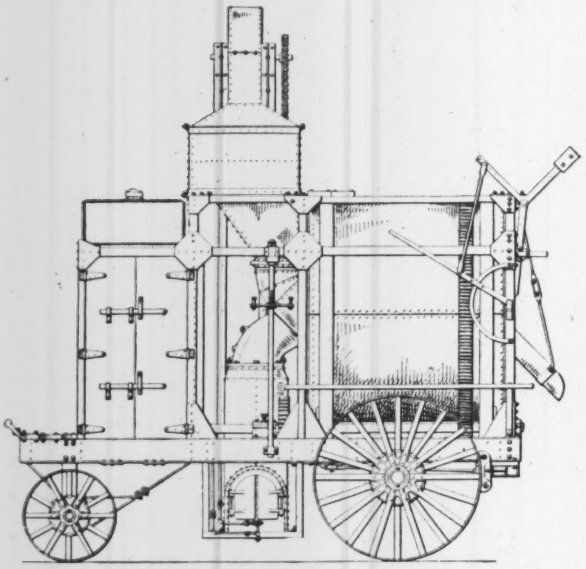
The accompanying table gives an itemized cost analysis of a week's work in constructing an asphaltic concrete pavement in Albany, Ore. The work was done by J. W. Travis, of Seattle, Wash., using a small portable mixing plant of the type shown in the accompanying illustration.

The mixer weighs, complete, 32,000 lb., is 18 ft. over all, 20 ft. high when operating and 15 ft. 8 in. high knocked down for moving. Its total width is 12 ft. 8 in. It is mounted on a steel frame with four heavy steel wheels and is designed to be drawn by four horses.

The mixing plant consists of a large steel drying, melting and mixing drum 8 ft. in diameter, fitted with

curved steel mixing blades, an inclosed elevator and hopper, charging spout with valve, discharging spout, and a special oil-burning air-heating furnace, a steam engine for driving the mechanism, and other accessories.

The drum is supported upon four heavy cast chilled trunnion wheels with steel shafts turning in babbitted



PORTABLE ASPHALT-MIXING PLANT WITH 8-FT. MIXING DRUM

bearings and is rotated by gearing directly connected with a vertical steam engine of 40 hp. Steam is supplied to the engine and the oil-burning furnace by a portable 40-hp. boiler of the locomotive type, which furnishes steam at a working pressure of 100 lb. per sq.in. Fuel oil is supplied to the air-drying furnace from an oil-storage tank mounted upon the truck.

The sand or stone is charged into the drum, and a blast of hot air from the furnace is passed through the drum, which in revolving causes the sand to be cascaded through the hot air until the moisture is driven off. Asphalt is then charged into the mixing drum from an auxiliary steam-jacketed measuring tank having a capacity sufficient for an entire batch. A part of the equipment is a portable melting kettle having a capacity of 900 gal. The time required for mixing is about 15 min. The only manual labor required is in measuring the materials and dumping them into the elevator. The outfit has a capacity of 800 sq.yd. of 2-in. asphaltic mixture in a day.

The type of mixer described is made by the Equitable Asphalt Maintenance Co., Kansas City, Mo.

TABLE SHOWING COST OF CONSTRUCTING ASPHALTIC CONCRETE PAVEMENT, ALBANY, ORE., WITH SMALL PORTABLE MIXER

Date—1914	Aug. 31		Sept. 1		Sept. 2		Sept. 3		Sept. 4		Sept. 5		Totals	
Run	Base		Base		Top		Top		Top		Top		Base	Top
No. loads	46		43		39		33		50		46		89	168
No. sq.yd.	800		748		1308		1142		1438		1316		1548	5204
Hr. worked	8		8		8		6½		8		8½			
Gravel, cu.yd.	65½	$49.00	62	$46.50	15	$9.75	14½	$12.50	22¾	$18.00	20½	$26.00		
Fine sand, cu.yd.	13½	20.00	14½	21.50	26	39.00	22	33.00	32½	50.00	30½	46.00		
Coarse sand, cu.yd.	10½	18.60	9¾	17.90	39	70.20	33	59.40	50	90.00	46	82.80		
Asphalt, lb.	10560	63.36	9600	57.60	17760	106.56	16320	97.92	21600	129.60	21120	126.72		
Fuel oil, gal.	350	10.50	450	13.50	400	12.00	250	7.50	400	12.00	400	12.00		
Labor, plant		44.20		36.35		38.25		41.35		37.85		42.85		
Wood, cords	1	4.00	1	4.00	1	4.00	½	2.50	½	2.00				
Teams	2	10.00	2	10.00	2	10.00	2	10.00	2	10.00	2	10.00		
Labor, street		32.50		35.00		39.00		42.00		42.00		42.00		
Coal		4.00		4.00		4.00		4.00		4.00		4.00		
Total cost		256.16		246.35		332.76		310.17		395.45		392.37	502.51	1430.75
Cost sq.yd.		32.2c.		32.80c.		25.44c.		27.16c.		26.80c.		29.80c.	32.46c.	27.49c.

Pavement consists of 3½-in. bituminous concrete base and 1½-in. top, Topeka specifications. Total number of men employed at plant 9.

Do Surveyors Use Traverse Tables?

In response to the note in ENGINEERING NEWS, May 6, under the above query, four engineers of experience agree that 10″ traverse tables would be far too bulky to be of practical use and volunteer many suggestions from their own practice and experience.

G. B. Zahniser, New Castle, Penn., expresses preference for log tables:

The usual field notes give angles to the nearest minute, often to the nearest half-minute. Distances are given to the nearest tenth usually, though often the notes give distance in hundredths, where the corrections for sag, temperature and pull are made (when will land surveyors be convinced that measures in hundredths mean nothing unless these three corrections are made?).

I first used Gauss' five-place log tables (85c.). After a while a minute traverse table with distances from 1 to 100 was bought ($7.50) and a six months' trial made of it. Gauss' table, because of its small size and compactness, was more convenient and rapid and resulted in fewer mistakes. It was not long before the minute traverse table was discarded.

For such courses as N 27° 31½′ W with a length of 1162.73 ft., for example, Gauss' is better than a minute traverse table, but not quite so good as a Vega log table, and if the work consists of many such courses the Vega table is the best.

If the Gauss table had the logs of numbers up to 20,000, or even to 15,000, instead of to 11,009, I do not see how a better table could be made.

Gauss also gives squares of numbers to 10,000 (these should go to 15,000). This table of squares is most convenient in calculating closing courses where corners are shot from a traverse, as is the best practice.

The junk in our textbooks and fieldbooks about traverse lines parallel to the courses surveyed needs to be roundly condemned by all engineering papers. It is responsible for more bad fieldwork than any other one thing taught.

A mechanical device from which the latitude and departure could be read by inspection was experimented with. This device is well enough in some ordinary work, but of course will not do where land is valuable. Mechanical calculators and multipliers, where natural functions are used, are probably the most rapid and accurate means of making calculations, but their cost is high ($250 to $300).

It has been my dream that someone would make a mechanical calculator on the keyboard of which you could first strike 27° 31½′ and 1162.73 ft., then yank the lever and read the result on the dial. Then, after making the necessary corrections to these latitudes and departures, you would strike them off on the same or another keyboard, yank the lever and read the area. The first part of this dream is well within the range of what is being done now, but the last part takes us back to Babbage and his plans.

My practice now is to use Gauss and Vega tables, and this as far as known is the practice all through western Pennsylvania and eastern Ohio.

Ernest McCullough, Chicago, Ill., gives the names of three published traverse tables: Boileau's, containing tables computed to 1′ of angle, price $5; Lewis & Caunt's tables, computed to 1′ of angle, price $2. The distances in both are carried out only to 10, so, as he states, considerable adding and shifting of the decimal point is involved. The third table is R. L. Gurden's, computed to

1′ of angle and with distances from 1 to 100, price $7.50. This is probably the same one referred to by Mr. Zahniser. Mr. McCullough writes:

I know a great many engineers and surveyors who use the above-mentioned tables, the Lewis & Caunt book being a handy size for the field and the Gurden book being better for the office, the pages measuring 10x14 in.

W. Newbrough, Detroit, Mich., considers Gurden's tables so bulky that for the most expeditious work two persons are required to calculate a traverse, one at the notes and one to handle the tables. For this reason he thinks Boileau's or Lewis & Caunt's is better, as one man can do both operations. He writes:

I have found that, using Boileau to calculate and Lewis & Caunt for the second or check calculation, about the same time is consumed as working the traverse by logarithms once. In my office we have worked out traverses of over 600 courses and in these find the time saved by traverse tables is considerable.

In the fieldwork of certain kinds of surveys, such as railroad and canal preliminaries, many of the courses can be made to read to the nearest 15′, and by this means calculation can be shortened a great deal by using tables.

In surveys for mineral claims, Boileau is valuable and rapid for solving triangles where two sides and the included angles are given, using the method of sines (latitude and departure) instead of the ordinary one of tangents.

E. B. Harger, Oxford, Conn., considers that a traverse table to show any advantage over a table of sines must give the latitudes and departures not merely for a distance 1 but at least for distances from 1 to 100, which would make a 10″ table too bulky to be manipulated. He writes:

I use a traverse table of ancient origin in Flint's "Surveying," published in 1837. This gives latitude and departure for each ¼° and for distances from 1 to 100; with two places of decimals the tables occupy 90 pages, 6x3½ in. To make a 10″ table, assuming that by the use of a larger page and smaller type the matter on each page can be doubled, would require 4050 pages.

The table I use can, by mental interpolation, be made to give results accurate to the nearest tenth, when courses are given to 1′ and distances (of less than 2000 ft.) to the nearest 0.1 ft.

Land Classification Surveys of Irrigable Tracts

By Kenneth A. Heron*

One of the first steps in colonizing irrigated lands is a survey to determine the irrigable and the nonirrigable acreage in each unit or lot offered for settlement. The 40-acre subdivision is the usual unit, and a land-classification survey is made to determine the classes of land in each unit and the amount of each class. Upon the figures thus obtained the selling price of the subdivision is determined. Where the acreage involved is large, a quick and economical method of surveying must be used.

Method of Survey

The following method was developed by the writer in classifying the lands of a large irrigation project in Colorado, and was later successfully applied to the classification of a 160,000-acre project in northern Montana:

A complete chained traverse of each section of land was made. Preliminary work consisted in staking out all ponds, seep, alkali, rock or other waste land in the section and the running of lateral lines from saddle points around hills or knolls to determine all land too high to irrigate economically. The latter is gaged by the value of the land and in different localities is taken as the saddle point, or so many feet or inches above the saddle point, based on the farmer's filling in low places.

The limits, or edges, of the various other classes of land are matters of judgment. The remainder of the fieldwork consisted of a stadia survey to locate these areas. Triangulation points were established in the section from known corners or points on the traverse survey, and from the triangulation points stadia shots were taken to all stakes on the edges of waste, high or other areas. As many triangulation points were set as were necessary to locate each area and to keep the length of sights within 800 ft. A continuous stadia traverse through the section was made at times and all small areas thus "picked up." A complete sketch of the section, showing all canals, laterals, high, waste or other spots, accompanied the field notes.

Office-Work

The office-work consisted of plotting to a scale of 200 ft. to the inch, the section traverse, and subdividing the section in the same manner in which it would have been done in the field. The subdivision was carried to 40-acre tracts. The notes were then plotted and checked, and the areas of the various classes of lands in each 40-acre tract were taken off with a planimeter.

Cost of the Work

An assistant engineer, with a transitman and three rodmen and chainmen, will classify in this manner about 8000 acres of land in one month under ordinary conditions. The necessary office work, plotting, computing, scaling, checking, etc., will require almost the entire time of two draftsmen. The time of these men with necessary supplies and supervision will make the cost of the work total about 10c. per acre, which is a very reasonable sum for a survey of this nature. Where the plan of actually setting the 40-acre tract corners in the field was followed, the cost ran as high as 40c. per acre.

*Irrigation Engineer, Modesto, Calif.

Building the Muskingum River Sand-Braced Pile Pier

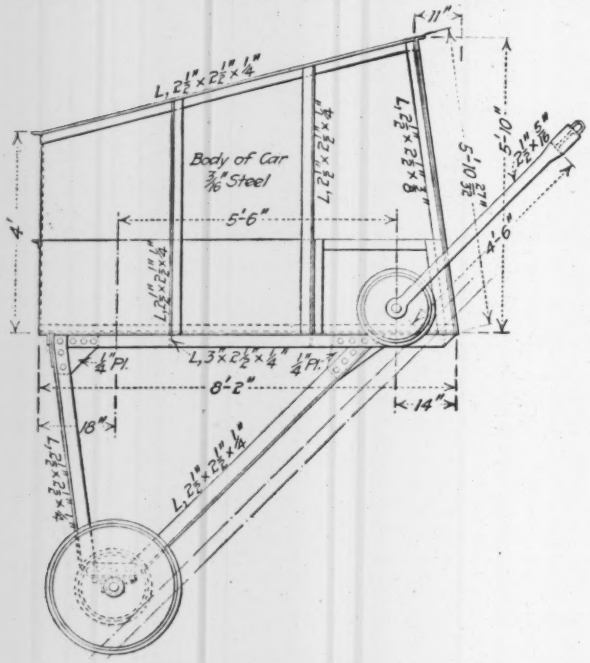
Having been superintendent for the contractors, I can offer a correction of the statement appearing in your issue of May 6, 1915, p. 890, regarding the construction of a temporary pier for the Muskingum River bridge of the Pennsylvania Lines near Coshocton, Ohio.

The box was built on ways ashore, launched, located, and sunk into the river bottom an average distance of 3 ft. This was accomplished chiefly by dredging inside. The cross-bracing and a top course of timber (not indicated in the figure) having been blocked up for the purpose, a platform of heavy timber laid across the top provided support for 58-ft. driver leads and engine. A No. 1 Vulcan hammer then drove the piles into hard ground an average penetration of 14 ft. The box was then filled and capped as described.

It would have been difficult, if not impossible, to work the box down, with its cross-braces, among the piles, if the reverse procedure had been followed.—Reginald Jackson, East St. Louis, Ill.

Kangaroo Refuse-Elevating and Dump Car

An automatic dumping car which dumps on being run from an inclined to a level track and which is designed primarily for use at garbage-disposal plants is shown by the drawing below. The car is in use at the refuse incinerator of Palo Alto, Calif., which was described in



REFUSE DUMP CAR USED AT PALO ALTO, CALIF.

ENGINEERING NEWS of Mar. 4, 1915, p. 432. Drawings of the car were not available at that time. The car is described as follows:

An electrically operated car receives the refuse from the collecting wagons, runs up an inclined track and, as it reaches the level, automatically dumps its contents onto the charging floor. The body of the car is 7 ft. 9 in. by 8 ft. 2 in. in plan and has an average height of 4 ft. 10 in. The body is made from No. 8 steel and is riveted to a steel frame composed of angles and gusset plates. At the rear end of the car are two sets of wheels, one 16 in. and the other 30 in. in diameter. As the car is pulled up the inclined track by an 18-hp. motor, it runs on the smaller wheels. When it reaches the curve at the top the 30-in. wheels engage a second set of rails which elevates the rear end of the car and causes it to dump by gravity. A set of 12-in. sheaves attached to the rear axle of the car engages a counterweight when going over the curve. When the car dumps, this counterweight pulls the car back over the curve, after which it descends by gravity.

The car was designed and built by the Universal Engineering Co., of which Neil McKay, 320 Market St., San Francisco, is Chief Engineer.

NOTES

Wood Borers in Halifax Harbor—In excavating for the new Pier 2 of the Intercolonial Railway at Halifax, N. S., a number of old pile stumps were found. These stumps were the remains of piles which had been eaten through by limnoria below low-water level. It was found that uncreosoted timber was eaten from extreme low water down to the mud level even when that was 30 ft. below. Several creosoted hard-pine piles that had been in the water about four years were found to have been attacked to a depth of about ½ in. No signs of the teredo were found; apparently, all of the boring in this harbor is confined to limnoria.

A Pipe Chute for Conveying Hot Rivets from forge to riveter is being successfully used in the erection of the third-track girders for the Ninth Ave. elevated railway in New York City. Instead of tossing the red-hot rivets to the riveters, the forge man drops them into the near-by mouth of a 2½-in. wrought-iron pipe which leads directly to a bucket alongside of the riveter on a staging some feet below the forge platform. Various pipe lengths are on hand so that the chute can be shifted to meet the distance, as well as the direction, of the riveter from the forge. Tossing the rivets would be difficult on account of the inaccessibility of the riveting stage and dangerous inasmuch as the work is going on over a traveled street.

Ant-Proof Frame Buildings at Darien—Ant-proof frame buildings are very desirable on the Canal Zone on account of the great activity of wood-boring ants. How these pests are circumvented in some instances is illustrated by the manner of supporting the frame buildings of the Darien Radio Station. These buildings consist of the operators' barracks, quarters for the officer in charge and quarters for the chief electrician. The buildings are supported on short posts which rest upon small individual concrete footings, into each of which is built a gutter 1½ in. deep by 2 in. wide. These gutters are kept filled with the standard larvacide used by the sanitary department of the Panama Canal, and it is stated that no ants have been observed in the houses since the cups were filled. The ant cups on the outer footings are roofed by a small concrete projection to keep out the heavy rains. Similar cups are installed on all water, electric and soil piping, and on electric wires leading into the buildings.

Observations on Polaris in Daytime—In connection with the article on "Azimuth Observations on Polaris by Daylight," by Robert V. R. Reynolds, in "Engineering News," Apr. 22, p. 779, the following extract from a letter by N. Spofford, Haverhill, Mass., in "Engineering News," Jan. 22, 1887, is of interest. Mr. Spofford wrote: "I have been engaged during a portion of the past season in the work of running a part of the Massachusetts and New Hampshire boundary line, opposite the Merrimac River, made up of a series of broken lines varying in length from 1 to 4 mi. To check angles taken at the intersection of the several courses, I have recently reviewed the distance passed over and determined the true bearing of each course, from observations on Polaris at elongation, commencing in October when the star was in this position about 5 p.m. and continuing it from day to day until Nov. 24, at which time I saw Polaris distinctly at 1:35 p.m. through the telescope of an ordinary engineer's transit instrument, manufactured by Buff & Berger, of Boston, which had an erecting eyepiece, magnifying to 25 diameters."

Shallow Cutting with a Steam Shovel—Macadamized gravel was recently cut from about 20 blocks of street in San Antonio, Tex., by a 14-B Bucyrus revolving steam shovel equipped with a ⅝-yd. dipper. The cutting averaged about 7 in. in depth, and the shovel loaded over 200 (maximum of 250) 1-yd. wagons per day of eight hours. This meant progress of about one block per day. From four to six wagons were used, the average haul being four blocks. The street was 38 ft. wide and devoid of street-car tracks. The grading was done in one cut of 34-ft. width. The 2 ft. on each side was excavated with a fresno, using one team and one man. The fresno led the way, throwing the material toward the center of the street in the path of the approaching shovel. This method allowed the curbers to work along on both sides of the street immediately behind the shovel. The curbers were followed by the steam roller, which prepared the street for the paving gang. According to "The Excavating Engineer" for May, the operating cost per day for excavating and hauling, not including overhead and repairs, amounted to about $48.

Saving $8000 on a Street-Repaving Job—By utilizing a worn-out brick pavement in Franklin, Penn., as the foundation for a new pavement, 8000 sq.yd. of new brick surface was laid by municipal day labor at a cost of $1 per sq.yd., or a total of $8000, as against a bid of $16,000 for taking up the old pavement and relaying the new on a concrete base. Conditions were such that the method of repaving adopted was particularly applicable. The curbing was 10 in. higher than the old pavement and the street had sufficient grade to insure ample drainage. The day-labor scheme was adopted because of the large number of local men out of employment and because the city could buy vitrified shale paving brick to as good advantage as a contractor. The new brick were laid on a 1-in. sand cushion on top of the old pavement, after the largest holes and depressions had been leveled off with concrete. After rolling the brick were grouted twice with 1 : 3 grout.—M. E. Griffen, Franklin, Penn.

Editorials

Fair Dealing between Contractors and Subcontractors

The Master Builders Association of Boston, in its monthly leaflet, calls attention to the injustice which bidders on subcontracts sometimes suffer at the hands of the general contractor. The latter may obtain from subcontractors bids for certain portions of the work and then, with this information, appear as a bidder in competition with the subcontractors. To oppose this unfair practice the Association many years ago adopted in its code of practice the following clause:

> A principal contractor, when making up his estimate, is not entitled to receive bids from subcontractors if he is at the same time making himself their competitor by figuring their portion of the contemplated work. It is legitimate for a principal contractor to figure all portions of work, depending upon no one for what are usually known as sub-estimates, but it is not legitimate for him to receive bids from others for sub-work and then figure those portions in competition with such sub-bidders.

An excellent plan for preventing unfair dealing of this sort, and at the same time insuring that the subcontractor will be acceptable, is for the architect or engineer to receive and award bids for those portions of the work which are to be subcontracted, and then invite bids for the general contracts, notifying bidders what subcontracts are to be included, and at what prices, in making up their bids.

Careless Estimating in Bidding on Contracts

Contractors at this time are unusually anxious for work, as is evidenced by the very low prices which are being bid on construction work. Few contractors, however, even to keep their organizations intact, bid on a job with the expectation of losing money; but the gambling element is such a large part of the contracting game that many contractors are willing to bid low for the sake of getting a contract, and trust to luck—or something worse—to get them out with a profit.

A low bid made as the result of close estimating and assurances of low prices for labor and materials is of course legitimate; but, not infrequently, low bids are the result of carelessness in estimating. An instance of the latter occurred recently at Columbus, Ohio. On May 5 the following bids were returned for a county bridge over Alum Creek: $116,764, $114,247, $103,953, $103,460, $102,758, $93,776, $75,404.

When the bids were made public and the low bidder saw what his competitors thought of the job, he demonstrated his business ability by obtaining the return of his check and "getting out from under." At considerable trouble to all concerned and financial loss to the contractors who bid, the contract will be readvertised.

We noted in our issue of Apr. 8 the contract let for a double-track railway bridge over the Susquehanna River at Harrisburg, Penn., on which the lowest bid was $270,290 and the highest, $633,690. It would seem hardly possible for such a wide difference as this to occur unless the estimate is carelessly prepared or the work is taken on a pure gamble.

Among the bidders on the Susquehanna bridge just mentioned was one who a few years ago bid on a concrete building—a class of work foreign to his previous experience. His bid was the lowest and he got the job. By the time the walls were up about all the money estimated as the entire cost of the building had been spent. A review of the estimate revealed that the roof had been forgotten.

Seeking Buried Information in Railway Valuation

One of the most difficult tasks in connection with the railway valuation work now in progress is the unearthing of information regarding expensive difficulties encountered during construction or in after operation, of which there is no present evidence to any one inspecting the line. It is an open question, of course, how much of these expenses will finally be allowed in computing the "replacement cost"; but the instructions to the valuation engineers are to ascertain these facts of past history so far as possible.

We have before pointed out in these columns that on many of the older lines of railway it will be impossible to obtain this information in anything like complete shape. It is of interest, however, to notice the endeavors that are being made to secure it. The receivers of the Cincinnati, Hamilton & Dayton Railway Co. have just had printed a large poster headed, "Information Desired for Federal Valuation." We quote from the poster as follows:

> The Government engineers will go over the railroad and measure and inventory the property. There are many items of property and elements of cost that will be overlooked because they are not visible or are forgotten or unknown. The railway company will have a representative with the Government party who will endeavor to point out all these hidden items. Information is requested from officers and employees having a personal recollection of conditions attendant upon the construction, improvement or operation of the property.

Then follows a list of 62 different items of work likely to be overlooked in a surface inspection of the line. All of these items involved expense to the railway, and, assuming that they were a necessary part of the work of construction and that the work was done with reasonable skill and economy, they are as legitimate a part of the replacement cost as are the cubic yards of earth in a fill, or the pounds of steel in a bridge, or the work in any other portion of the completed railway that can be readily seen and measured.

It is, of course, an open question as to whether items of cost which have become obsolescent should not be removed from the valuation, and the capitalization be reduced correspondingly. For example, in the original construction of railways built forty years or more ago, the rock cuts and rock tunnels were made with hand drills and

black powder at enormous expense. This cost ought not to be a perpetual burden upon the property nor upon the public which makes use of the road, but should eventually be reduced to the amount at which the same work could be accomplished with modern drills and explosives.

It is fair to say that in this respect the railway companies of the United States have been more conservative than those of Great Britain. A large proportion of American railways expend annually a considerable part of their earnings in improvements and betterments. In Great Britain all such work has been charged to capital account, practically regardless of the obsolescence that has taken place. This is one reason why the railways of Great Britain have a capitalization per mile far in excess of those of any other country.

The Success of Two Municipal Garbage-Reduction Plants

The city of Columbus, Ohio, which has for 4½ years owned and operated its garbage-reduction plant, finds that the revenue from the operation pays the entire operating expenses and fixed charges on the plant, including interest and depreciation. Detailed figures showing the results obtained at the Columbus plant in the years 1913 and 1914 are given in an article elsewhere in this issue, compiled from the annual report of T. D. Banks, Superintendent.

Last year 21,600 tons of garbage was treated at an average cost per ton of $1.86, and the sale of the grease, tankage, etc., obtained from the garbage yielded a revenue of $3.085 per ton. The net earnings were $26,500. To obtain accurate figures for depreciation, the life of each building and machine in the plant was appraised and an estimate of its probable life was made. As the plant has now been in operation for 4½ years, it was possible to make an estimate of the probable life with a good degree of accuracy. By this appraisal the annual charge for depreciation was fixed at $11,800, or about 5% of the total valuation of the plant, $184,000. The annual charge for interest on the 4 per cent. bonds issued to build the plant is $9475, making a total interest and depreciation charge of $21,275. Thus, the plant returned a revenue to the city of a little over $5000 after paying all fixed charges. It should be understood that these figures cover the cost of disposal alone and do not include the cost of collecting the garbage, which obviously must be done anyway, whatever process is adopted for disposal.

It is of interest to note that the figures for net earnings per ton of garbage at the Columbus plant are very close to those obtained at the Cleveland municipal garbage-reduction plant, the results of which were reported in our issue of Mar. 18. The Cleveland plant, of course, is a much larger affair. It deals with the garbage of a city of 700,000, while the population of Columbus is about 200,000. The Cleveland plant last year handled 65,730 tons of garbage, the Columbus plant 21,630. The former was operated at a cost of $2.54 per ton of garbage handled, the latter at a cost of $1.86. The gross earnings per ton of garbage were $3.49 in Cleveland and $3.08 in Columbus. A considerable part of the larger revenue per ton of garbage in Cleveland appears to be due to the higher percentage of grease in the garbage in that city, which is what would naturally be expected from a city having a much larger proportion of wealthy and well-to-do in its population. The Cleveland plant was originally built by a company and was later bought and improved by the municipality. In Columbus the city built the plant from designs made by I. S. Osborn as engineer.

Garbage-reduction plants owned by private companies and operated under contract with cities have been in use in the United States for a long time, but nearly all such plants have operated under a severe handicap of uncertainty as to renewal of contracts and a consequent tendency to permit the plant to deteriorate when the contract neared its expiration.

Municipal ownership and operation of garbage-reduction plants might almost be termed an Ohio idea. For several years Cleveland and Columbus had the only other city-owned reduction plants and at present Akron has one about completed and Dayton has one under way. Early in 1914 Chicago took over the privately owned reduction works and has since been extending them. Late in 1914, Schenectady put in operation the municipally owned plant described in our issue of Apr. 29, 1915. Detroit has made plans and received bids for reduction works.

A great handicap to the adoption of municipal ownership for garbage plants hitherto has been the lack of accurate and reliable data upon such plants, those owned by private companies naturally permitting no publicity concerning their operation. Both the Cleveland and Columbus plants, however, have afforded data for a number of years past which are of great interest and value to all engineers, contractors and city officials concerned with garbage disposal. It is sincerely to be hoped that equally full and useful records will be kept by the other city-owned plants.

A New Heavy Rail Section

At the meeting of the New York Railway Club on Friday, May 21, Gustav Lindenthal presented a paper entitled "The Qualities of a Good Steel Rail," in which he offered for criticism and discussion a new type of rail section. We say a new type, but hasten to add that this section may from one point of view be considered a revival of the old bridge, or inverted U, section of rail, originated by the famous English engineer Brunel, and used for many years on the Great Western Ry. of England in connection with a system of longitudinals instead of cross-ties. We believe that the same type of rail was used about 1840 on a considerable mileage of the old Western Ry. of Massachusetts.

This early use of the U-rail really antedated the T-rail. In England at that time the double-headed rail had superseded the strap rail, but the former required the use of chairs. Brunel desired a rail that could be laid directly on the timber longitudinals and so developed the U-rail.

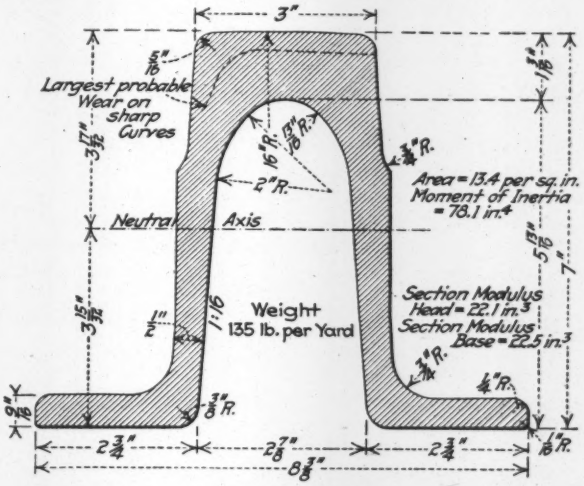
Of course, all this was in the days of light wrought-iron rails and light traffic, in the infancy of railway development. The reasons that have caused the U-rail to be brought forward by so high an authority as Mr. Lindenthal have to do with matters that were unknown and undreamed of in connection with the little old wrought-iron U-rails of seventy-five years ago.

Under modern heavy wheel loads and very heavy traffic, the present heavy-section steel rails are in many cases showing rapid wear, and the percentage of broken rails is uncomfortably high. It is certainly worth consideration

whether for such traffic conditions the U-rail might be substituted for the T-rail, especially when the proposal comes from an engineer of such distinction.

The principal argument of Mr. Lindenthal in favor of the U-section is that it would permit thorough working of the metal in the head of the rail in passing through the rolling mill, thereby securing a density and fineness of grain that are admittedly lacking in most of the heavy-section rails now rolled and that are believed to be of great importance in enabling rails to resist wear.

It is a very generally held belief among railway engineers that none of the present-day rails of 90 to 100 lb. or heavier give anything like as long a service as did the early steel rails of 52 to 70 lb. weight. Mr. Lindenthal expresses that belief in his paper. The reason generally assigned for the poor service of the heavy rail is that the steel is rolled at such a high temperature, partly from the desire to turn out a maximum tonnage, that the metal



PROPOSED RAIL SECTION OF INVERTED U-FORM FOR HEAVY TRAFFIC

is not thoroughly worked and consolidated in the rolling process, especially in the interior of the thick heavy head.

The ordinary T-rail is formed in the rolls from a billet of rectangular cross-section, and the head receives comparatively little working in its passage through the rolls. The U-rail, on the other hand, is first rolled out to a broad plate (thickened at the center, which will ultimately become the head of the rail), and in the final passes through the rolls this plate (some 18 in. in width) is given its final U-shape form. It is entirely reasonable to believe that the metal in such a rail would be much more thoroughly worked than is the metal in a T-rail of a corresponding weight per yard.

From the point of view of safety there is little doubt that this section would give less trouble with broken rails than the present T-rail section. Some bad railway accidents caused by broken rails in recent years have been due to splitting of the head of the rail. It will be evident that the T-rail head, projecting beyond the supporting web is a weaker section than the U-rail where the head is supported by a web on each side.

There are some other good features about the U-section. One is its great width of bearing on the ties—8⅜ in. This should reduce the tendency of the rail to cant and cut into the tie or bend the tie-plate, especially on curves. The great depth of the section (7 in.) makes it exceedingly stiff. The late A. M. Wellington used to say that the thing to buy in purchasing rails was not pounds of steel but stiffness.

One reason why the old U-rail was abandoned was the difficulty in making a satisfactory joint. Mr. Lindenthal thinks there would be no difficulty in making a joint with this type of U-rail that would give the same transverse strength as the rail. He does not explain what he would propose for a joint, however. Apparently, it would be necessary to use a bridge type of joint with a piece rolled to fit the space between the webs and its ends supported by the tie-plates on opposite sides of the joint. At switches and frogs the T-rail section would be used.

One difficulty that might be experienced with the rail would be its bending to fit sharp curves on account of the great width of its base. Probably, some care would be requisite both in handling and in curving, not to bend the two sides unequally. It might even be necessary to substitute T-rails on curves of small radius. It is to be remembered, however, that this very heavy-section rail would be used only on lines of the heaviest traffic, and on such lines very sharp curves have generally been eliminated.

Another possible difficulty that might be found in rolling this rail is the unequal amount of metal in the head of the rail and in the flanges. It is possible that the thin flanges would cool so much more rapidly than the head that it would not be possible to finish the latter at the low temperature and secure the thorough working that is looked for as one of the chief advantages of the section. It is well-known that in the standard sections the flange of the rail has purposely been thickened up and made very heavy so that its rate of cooling will be more nearly equal to that of the head.

The great weight of the section—135 lb. per yard—may seem to place it outside the field of practical railway operation. It must be understood, however, that this heavy section is proposed only on lines of densest traffic. Mr. Lindenthal states that the Central R.R. of New Jersey is already using a T-rail of this weight per yard, while the Pennsylvania R.R. has placed in its track no less than 15,000 tons of a 125-lb. section. If, therefore, the U-section could show greater safety against breakage and greater resistance to wear, and if it could be rolled at the same cost per ton, there is no reason why it should not come into use. What the relative cost of rolling the T-section and U-section would be, probably only experience would develop. The rolling-mill experts would be very apt to claim that the U-section would be more costly to roll, on the principle that anything different from long-established practice is always more costly. On the other hand, it is difficult to see why this section should be any more difficult or expensive to roll than a channel or I-beam of the same weight, and these are now selling at about 1.2c. per lb. at the mill, or $24 per ton, a considerably lower figure than the standard price for steel rails. It is pretty well understood, however, that this difference in price does not represent the difference in the actual cost of rolling the respective sections.

A point emphasized by Mr. Lindenthal in the discussion of present-day rolling-mill practice is the necessity of finishing the metal at lower temperature in order to secure thorough working and the desired density in the finished rail. He recommends slower rolling in the

last two passes of the rail. This would mean, of course, a material reduction in the daily output and a corresponding increase in the cost of production of the rail. It is interesting to consider whether the U-rail, with its wide thin section, could not make these results obtainable without decrease of the speed of rolling. It is possible that the different rate of cooling of the head and foot already referred to could be at least partly offset by directing a water spray on the head.

There is another possible advantage of the U-rail that we believe deserves some consideration, and that is the possibility of obtaining a wider bearing surface for the car wheel. The 135-lb. rail section shown by Mr. Lindenthal has a head 3 in. wide. In comparison, the Pennsylvania Railroad's 100-lb. section has a 2½-in. head, and its 125-lb. rail section has a head 3 in. wide. Suppose, however, we were to consider the use of the U-rail not alone for such extraordinarily heavy sections as that shown herewith, but for sections of 85 to 100 lb. weight. It would be possible in such sections to obtain a width of rail head materially greater than is possible with a T-rail. Suppose it were possible to furnish U-rails of these sections with a top, say 3 in. in width; would not such a wide bearing surface reduce the unit pressure of present-day heavy wheel-loads and add materially to the life of the rail?

If any of our younger readers think this is a novel or revolutionary proposition, we suggest that they hunt up in the *Transactions* of the American Society of Civil Engineers a remarkable paper entitled "Cylindrical Wheels and Flat-Top Rails," by Don J. Whittemore, for many years Chief Engineer of the Chicago, Milwaukee & St. Paul R.R. This paper made a great sensation in railway circles when it was presented, some twenty-five years ago, and any engineer who is wrestling with the problem of rapid wear of railway wheels and rails will do well to hunt it up and carefully study it over at the present day. Mr. Whittemore clearly demonstrated that even at that day, with the comparatively small wheel-loads and light traffic then prevailing, the typical railway-car wheel was a cylinder rolling on a plane surface and not a cone rolling on a rounded surface, as the theoretical designers of rail and wheel sections used to believe and to practice.

It cannot be said that Mr. Whittemore's paper had any great effect on practice in the design of wheel and rail sections at that time; the ideas he put forth were too far in advance of current thought. The change in personnel which has taken place in railway-engineering departments since that time, however, ought to have been favorable toward following what scientific facts have proved rather than established precedent. It is with this idea in mind that we earnestly commend the study of Mr. Whittemore's famous paper. The inevitable conclusion from it is that rails should be rolled with a flat top instead of crowned and that the head should be made as wide as other considerations will permit.

As we have already pointed out, the U-rail lends itself to a wide head far better than the T-rail. It is, of course, realized that one unfortunate detail of the present situation is that the present type of rail head wears a hollow in the wheel treads, so that a rail head materially wider than the standard would be likely to have its outer edge crushed down by the so-called false flange on the wheel tread. If this is an objection, however, it will apply as much to the 3-in. wide heads already in use experimentally as to the widening of the heads of 90- or 100-lb. rail sections to 3 in.

A change must be made somewhere if the unit bearing pressures between rail head and wheel are to be kept down to reasonable amounts. It is to be hoped that Mr. Lindenthal's suggestion that some of the trunk-line roads put the U-rail into use on an extended section of track and observe its behavior will be carried out.

Letters to the Editor

Superelevation on Curves in Highway Construction

Sir—The practice, which is rapidly gaining in vogue, of "banking curves" on highways places a premium on automobile speeding and cutting corners, makes the road dangerous for pedestrians and horse-drawn vehicles, and is very destructive to the road surface. In railway construction superelevation of the outer rail on curves is a necessity for high-speed trains, but a similar practice should find no place in highway construction.

With a banked cross-section the wear on the road surface all falls on the inside of the curve, and this, combined with wash across the road due to improper drainage, soon disintegrates any ordinary country-road surface. Therefore, a level cross-section should be maintained on all curves. This, too, will compel speeders to use caution in rounding curves and distribute the wear over a wider area. If highways are going to be laid out to make speeding easy, we may expect collisions and casualties to increase.

There is no defense of banking curves except to permit speeding. Our highways are built for all, by all, and should be so constructed as to be of the greatest benefit to all. Instances can be shown where superelevation has made it almost impossible for teams to use the road in slippery weather.

F. W. Harris,
Recently Locating Engineer, Washington State Highway Department.
Renton, Wash., May 15, 1915.

The New York Telephone-Rate Revision

Sir—Your editorial note on the New York telephone-rate revision in the issue of Apr. 8 was so evidently the result of misinformation that in justice to the Foley Telephone Committee of the New York State Senate and Assembly, and to the Chicago City Council, I feel it to be my duty to call your attention to the following:

1. The telephone rates just adopted by the Public

Service Commission of the Second District were not worked out by the company but by the above-mentioned Foley committee, with such assistance as I could give them, and were adopted almost *en bloc* by the Public Service Commission, save that the reduction was about 7% less than the committee had recommended.

2. The rate reduction in Chicago in 1907, and again in 1912, was greater than in Boston, and quite as scientifically carried out, although your editorial refers to Boston as having the first thorough telephone-rate revision.

I speak with assurance on these points, because I was in charge of the second Chicago investigation, as well as of the investigation of the Foley committee.

E. W. BEMIS.

4500 Beacon St., Chicago, May 3, 1915.

[The public records show that on Feb. 24, 1915, the Foley committee transmitted to the Public Service Commission for the Second District a schedule of rates and service which it recommended should be put into effect. On Mar. 4 the New York Telephone Co. filed with the Public Service Commission a schedule which it proposed for adoption. These two schedules were similar in their form of statement, but they differed in the number of zones and the charges for the various services. The order of the commission, dated Mar. 30, 1915, embodied the proposals of the company, except that it started some of the schedules at lower rates and lighter services, that it established wider local-call overlaps between zones and that the private-branch-exchange schedules were consolidated for zones 1 to 8 at the lower figures. Therefore our statement which Professor Bemis first criticizes is in accordance with the records beyond which, of course, there was no reason to go.

Evidently the rearrangement of service and the adjustment of rates on a complete zone basis were the logical development of the partial-zone system which had been previously employed in New York City by the telephone company, as shown by the older rates on file. It is quite possible that the numerous conferences between the telephone company and both the Public Service Commission and the Foley committee necessary as this case developed may have led to an exchange of ideas on acceptable arrangements which would give all parties concerned some credit for the various features of the rate schedules and service plans submitted to the commission.

We called the rate revisions in Boston and New York "more thoroughgoing" than the ones in Chicago, since the former involved the redivision of large districts into neighborhood zones, with an attempt to adjust the services and rates in accordance with the varying requirements of different areas. The Chicago revision, on the other hand, while preceded by a careful scrutiny of all the available data, and resulting in considerable reductions, did not involve a material rearrangement of the service basis.

The Boston revision was more thorough than the New York, since it was not limited to the confines of the city, but included the whole metropolitan district. That was manifestly impossible in the New York case on account of the intervening boundary between New York and New Jersey, which gives a political separation not in accordance with the limits of commercial activity.—EDITOR.]

New York Central Specifications on Compression Members

Sir—In the editorial in ENGINEERING NEWS of May 13, 1915, concerning the failure of the large crane on the Panama Canal, the editor refers to the New York Central Lines' specifications for 1910, commenting on the requirements for lacing bars in columns as set forth in paragraph 74 of the specifications.

We wish to call attention to the requirements of these specifications as set forth in paragraph 66. The last sentence requires that the column must be made up of solid webs at right angles wherever practicable. This has been the practice of the New York Central Lines, and purely open laced columns are only allowed in minor compression members and where it is evident that conditions will not allow of solid webs at right angles. It will thus be seen that the specifications are the first in this country at least to put the emphasis on first-class solid-web column construction throughout. If the compression members in the crane had been built according to paragraph 66, there could not have been any failure of the compression members, other things being equal.

Paragraph 74 is, of course, intended to apply where it is evident that solid webs at right angles cannot be used.

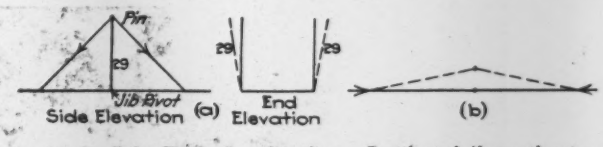
The writer wishes to call attention to the requirements mentioned, as it seems to him the editor did not catch the full import of the New York Central Lines' specifications on compression members.

B. R. LEFFLER,
Engineer of Bridges, N. Y. C. R.R. West of Buffalo.
Cleveland, Ohio, May 17, 1915.

Failure of Panama Crane

Sir—Referring to the failure of the Panama Canal crane (ENGINEERING NEWS, May 13), I should like to emphasize a feature of the design that is not given much prominence in your excellent description. In my judgment this failure was not due to weak latticing in member 29. Heavier lattice bars might have changed the nature of the failure of the member, but could scarcely have prevented it.

This failure is one piece with some others, among which



is the Buffalo Pumping Station. In that failure the two compression members of the trusses (the top chords) were not held in any way at the peak. The sketch indicates at (*b*) what happened: The free ends of these members were pushed out of line, and of course the trusses dropped. Every truss built this way dropped; those that were held at the peak stood up.

At (*a*) the sketch indicates typically the condition in this crane. The members 29 were not held against lateral displacement. In this condition it was easy for these members to assume positions indicated by dotted lines. In this position the lattice would be tremendously overstrained, not because it is weak, but because the frame is improperly designed. The member, in crumpling,

would naturally snap off the lattice bars, but this is merely an incident in the collapse; a member very much stiffer in the latticed portion would have failed, but the failure would have taken a different shape.

The designer of the reinforcement evidently realized that heavier lattice bars would not overcome the weakness, for he used heavy stay diaphragms at the end near the jib pivot, 14 ft. long, in planes normal to the frame. This very greatly improves the strength of the frame and compensates for the upper end of the member being free.

Deductions as to the stresses in lattice bars based on the failure of a member such as this are of little value, because the frame and the member are improperly designed. This is not a member held at the ends, as nearly all compression members are. In a member free at the end where the load is applied the lattice bars have quite a different office from that which those in an ordinary compression member are called upon to perform.

I do not believe there is anything in the way of test or theory that will show the need of provision in the lattice system for a shear greater than about 1% of the direct stress in ordinary compression members. Some tests were made on members having very thin webs that violated the ordinary rules of design of compression members. These showed a greater shear than 1%, but this was for the very reason that the members were improperly designed. The buckling of thin webs would put undue stresses in lattice bars, which would not occur in properly designed members. The same experimenters who found the high stresses in these lattice bars of the improperly designed member found scarcely any stress in lattice bars of a properly designed bridge member in service.

EDWARD GODFREY.

Monongahela Bank Building, Pittsburgh, Penn.,
May 14, 1915.

A New Type of Asphalt Pavement

Sir—Charleston, W. Va., has just laid an asphalt pavement of a new type. The mixture is of mineral aggregate, asphalt and wood, the wood being in the shape of small chestnut fiber from which all the natural juices and acids have been removed. The new pavement promises to combine the good qualities of both wood and asphalt pavements.

The Wood Fiber Asphalt Co. is developing this type of pavement under patents which it owns, and the first pavement laid is this one in Charleston, which was laid by the Central Engineering Co., contractor. Both companies have their headquarters in Charleston.

The specifications follow the standards of the American Society of Municipal Improvements as to materials. The construction plant used was one of the new Hetherington & Berner portable asphalt plants, with some additions to handle the drying of the wood fiber safely. The plant is shown in the accompanying view.

The wood fiber (in sacks at the left of the picture) is fed to the elevator, whence it goes through the drier without coming in contact with the flame or hot gases, thence through the screen, which rejects the large fibers seen in the pile at the side of the machine. From the screen the fiber drops into a bin, then to the hopper for weighing and to the mixer, where weighed quantities of mineral aggregate and hot asphalt are added and mixed together and dropped into a cart below.

After being dumped and rolled, a squeegee coat and stone screenings are applied, and the rolling continued until the wearing surface is thoroughly compacted.

CHARLES C. BROWN,
Consulting Engineer.

Indianapolis, Ind., May 18, 1915.

[The incorporation of vegetable matter (in the form of sawdust) in an asphalt pavement was first tried, so far as we can determine, on the Cocoanut Grove road in Dade County, Fla., in February, 1914. A sample stretch of this pavement 110 ft. long contains from 30% to 40%, by bulk of sawdust, the remaining aggregate being sand. About the same time a similar pavement was laid on Fourth Ave., Decatur, Ala. The inventor of these pavements is B. R. Reno, General Superintendent of the Southern Asphalt & Construction Co., Birmingham, Ala., who wrote us that the idea was suggested to him by the trouble and expense of securing a properly graded mineral aggregate in the Southern States. We have been unable to find out in just what condition these pavements are at the present time—EDITOR.]

CONSTRUCTION PLANT FOR BUILDING ASPHALT-WOOD FIBER PAVEMENT, CHARLESTON, W. VA.

Improving the Quality of Steel Rails for Heavy Traffic

How steel rails may be improved was discussed before the New York Railroad Club on May 21, in connection with a paper by Gustav Lindenthal, Consulting Engineer, entitled "Qualities of Good Steel Rails." The author charged the present methods of rail manufacture with responsibility for the unsatisfactory performance of modern rails; that is, their failure under modern excessive wheel-loads by breakage and by wear. His primary recommendations were to revise the methods of rail manufacture so as to secure sound steel in the ingot and fine-grained well-worked material in the rolling. Holding the metal in the ladle before pouring the ingot, devising a method of pouring which will eliminate piping and slow rolling with a largely increased number of passes were his chief recommendations to this end. Reducing the shrinkage allowance to 4 in. was also stated to be reasonable. The mechanical difficulty of rolling the T-rail section—that is, the impossibility of getting thorough and uniform working of the metal in the head—was declared to be a fundamental evil. With a view to getting around this latter difficulty Mr. Lindenthal has designed a double-web rail of inverted U-section weighing 135 lb. per yd. The metal in this rail, rolled flat and bent into the U-shape in the final passes, would receive very thorough working in rolling.

Discussion by a number of railway experts of prominence developed either a neutral or hostile attitude toward the new rail section. This was stated most clearly by G. J. Ray (Chief Engineer, D., L. & W. R.R.), who said that the expense of rail fittings, difficulties in making frogs, switches, etc., would make the new rail very expensive, while on the other hand the uncertainties of rail behavior are such that nothing could be known as to the value of the new rail until after several years' practical experience in the track, during which time many thousands of tons of the new section might have been rolled and put into use, without knowledge as to the ultimate value or reliability of the section.

Mr. Ray gave much valuable information as to rail experience on the D., L. & W. It is impossible to be sure of getting good rails by paying a high price; rails bought at even $80 a ton have proved just as much subject to failure as rails of ordinary cost. Experience has, however, shown that too high carbon in rails is decidedly bad. Extensive breakage of some high-carbon rail orders within six months after being put in the track was the final demonstration of this. These rails had 0.80 carbon minimum, ranging up to 1.00%, whereas rails of the present standard of the company, with carbon 0.70 to 0.83, give high ductility. These rails further are made from reheated blooms, which method is found to give higher ductility than direct rolling. He also said that brittle rails are a greater danger than piped rails, since the latter fail not by breaking, but by crushing or splitting, which is less dangerous. Transverse fissures have never appeared in 80-lb. rails, but any number of them in 90- and 100-lb. rails. The 125-lb. rail cannot today justify itself by saving operating expenses through permitting heavier loading or by saving in maintenance. He called for a reduction of the flat-spot limit for wheels allowed by the M. C. B. Association.

Robert Job declared that testing of every ingot is practicable and is a very sure way to get control of piping and similar unsoundness. By balancing the section of the T-rail, rolling can be improved until really fine grain is secured.

W. C. Cushing (Pennsylvania Lines West), who expressed himself as being largely in agreement with the author, came out strongly in favor of improved ingot-casting methods (such as the top-feeding method) to avoid piping. The Pennsylvania R.R. will shortly lay a considerable amount of rail made by such a method. Mr. Cushing said further that experience on the Pennsylvania with the 125-lb. rail section shows that increasing the stiffness of the rail is the proper direction of improvement.

H. E. Van Ness (Asst. Engr., Central R.R. of New Jersey, presenting facts and views prepared by J. O. Osgood, Chief Engineer) gave in brief the experience with the notable 135-lb. rail which has been in service on the Central of New Jersey for five years. This rail, designed as a 50 per cent. increase on the 90-lb. rail section, is intended for service on curves of 9½ to 13½° where ordinary rails rapidly wear out. The first of this rail was laid in 1910; 6000 tons have now been laid, and more will be ordered this year. The carbon specification has gone down from 1.16 to 1.23% in 1910 to an 0.80-0.95% range with 0.89 desired at the present time. The rails at present contain 0.20-0.40 chromium and nickel, however. The rail has already developed three times (and in places five times) the life of 90-lb. rail and is still good for service. Because of the longer life, on one curve of 13° 20′ the annual costs are as $1300 per mill for the 135-lb. rail and $2200 for 90-lb. rail; this comparison includes no allowance for the reduced cost of track maintenance and the increased operating value of the heavy-rail track. The 135-lb. rail probably gains in service value through its increased girder strength, but the main purpose in using it is to secure greater resistance to wear.

C. E. Carpenter (Maintenance Engineer, Interborough Rapid Transit Co., New York) said that, with wheel-loads in the subway only one-half those of trunk lines, there are quite a few breakages of rail. These are practically all due to clearly defined defects in the rail. One lot of special rails made from ingots poured with large end up has shown no failures. At sharp curves in the subway manganese-steel rails are used.

C. E. Bronson (speaking for P. H. Dudley, New York Central Lines) expressed agreement with the author as to many points concerning rail manufacture. He laid emphasis on the high wheel-loads of the present time and on the stresses in the rail, which have been measured with the Dudley "stremmatograph." Tests have shown that increasing the speed of a train from 6½ miles to 60 miles per hour increases the stress in the rail by a percentage which is greater for light rails than for heavy rails (50% for 80-lb. rails, 30% for 100-lb. rails). The importance of girder strength is clearly shown by these measurements. The opinion of many motive-power men today is that passenger-locomotive wheel loads of 34,000 lb. are too high and that it is better to keep the maximum wheel load below 30,000 lb.

Pavement Work in Fargo, N. D., a city of less than 20,000 people, will amount to $140,000 during the present season. Three large contracts were recently let, which include both business and residence streets. In addition the city will do much sewer and water-main extension work. The city engineer is Frank L. Anders.

Concrete-Block and Cellular Retaining Walls

By W. S. Lacher*

In connection with the structures for track elevation at Milwaukee, Wis., by the Chicago, Milwaukee & St. Paul Ry., unusually poor foundations have been encountered. Test piles and wash borings established the necessity for piles from 75 to 80 ft. long, with the bearing per pile limited to about 15 tons. This would result in very expensive work, particularly for retaining walls, so an effort was made to devise a type of wall which would eliminate the pile foundation. The investigation resulted in two designs, both of which were much cheaper than any requiring piles. While each of these involved a disregard for ordinary standards as to security against movement and settlement of the structure under load, they insured sufficient factor of safety against actual failure to warrant their adoption.

Concrete-Block Retaining Wall

The first design is an adaptation of the dry stone wall, and consists of concrete blocks placed one upon the other with horizontal beds, each course being offset from the course below so as to give the wall an appreciable batter. This is shown in Figs. 1 and 2. In order to give resistance to sliding, the blocks were made with corrugated upper and lower faces by casting them in forms lined with corrugated iron.

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Ribs extending back into the embankment were provided at intervals of about 9 ft., composed of headers interspaced with small blocks. These ribs served simply to support the wall until the embankment was placed and were not intended to add to the stability against lateral earth pressure. One wall of this type was built, but further use was discontinued in favor of another type which proved superior in several respects.

Cellular Concrete Retaining Wall

The other type is a reinforced-concrete cellular retaining wall, based on the idea of the timber crib, adapting it to monolithic construction rather than unit concrete construction, as has been done in some instances. It consists of a series of rectangular bottomless monolithic boxes of reinforced concrete, as shown in Figs. 3 and 4. The wall is analyzed according to the ordinarily accepted methods, except that it is assumed that the passive resistance against the front face of the rear wall will exactly counterbalance the active earth pressure on the rear face. The resistance to the overturning moment of the active earth pressure against the front wall is afforded by the weight of the entire wall and that of the earth superimposed on the back and side walls.

In the design the distance between the front and back walls was varied by trial until the section was obtained which gave the desired foundation pressure conditions, namely, that the bearing pressure would be practically uniform under the entire base of the section for the as-

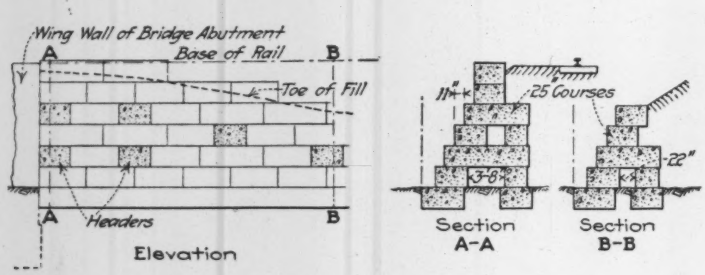


Fig. 1. Retaining Wall of Heavy Concrete Blocks; C., M. & St. P. Ry.

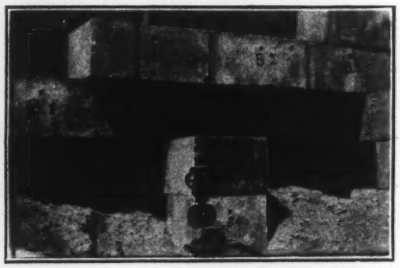


Fig. 2. View of Blocks in Wall

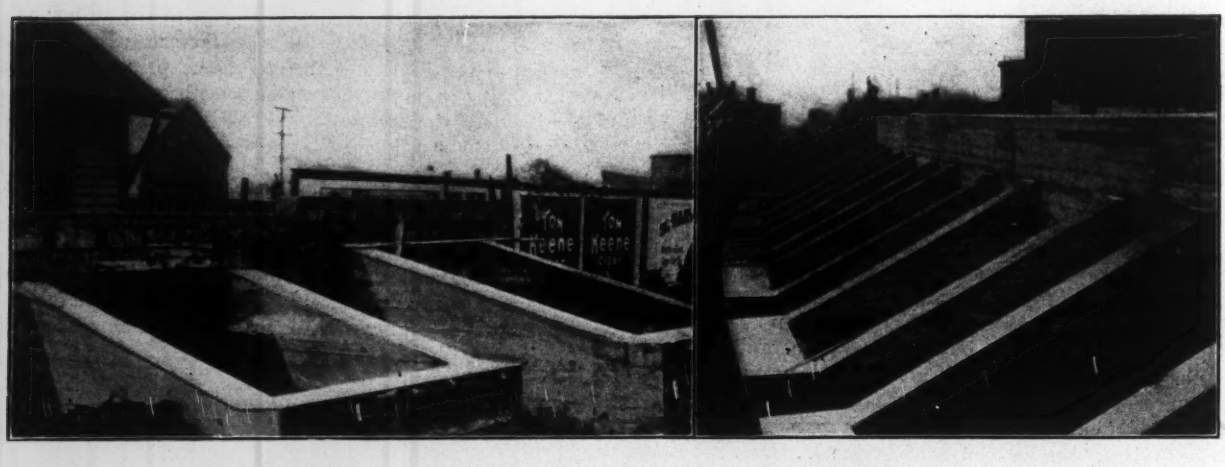


Fig. 3. Cellular Retaining Wall on C., M. & St. P. Ry.

sumed condition of loading. For the greater heights it was found that, instead of carrying the rear wall back the required distance, it was more economical to increase the top width so that it would carry a greater earth load. This is shown by the lower section in Fig. 4.

The four walls making up the cell are designed to take the loads applied to them according to ordinary reinforced-concrete practice. The stress in the front wall is reduced by spacing the side or tie-walls in such a manner that the front wall acts as an overhanging slab. On the other hand it was found undesirable to extend the rear wall beyond the limits of the tie-walls. As it is anticipated that these walls will settle materially and also tip either forward or backward to some extent, an allowance of 9 to 15 in. has been made in the height of the wall

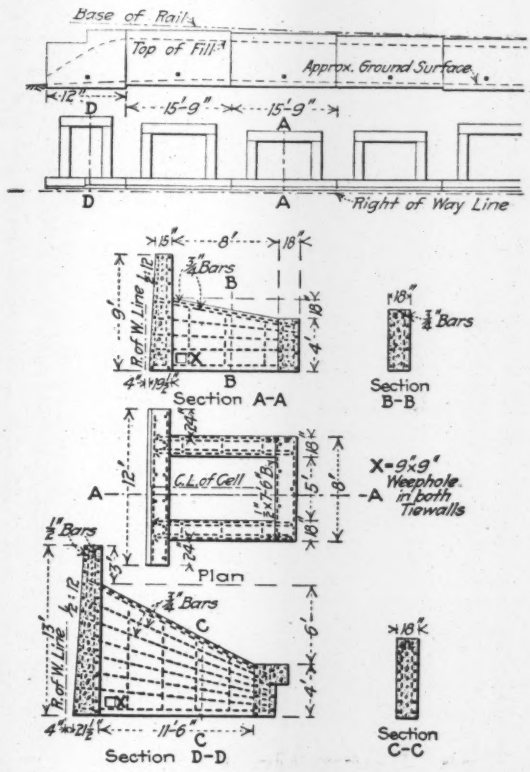


FIG. 4. RETAINING WALL OF MONOLITHIC CONCRETE CELLS (WITH EARTH FILL); C., M. & ST. P. RY.

and the front face has been set back 4 in. from the property line and battered to such an extent that the expected settlement will not result in encroachment upon adjoining property.

These walls depend largely upon the weight of the embankment for their stability and it is expected that they will settle with the embankment. Consequently, footings were considered unnecessary. The ground is simply leveled off to an even bed for the erection of the forms for the neatwork.

In order to permit the use of stock length of lumber, the sections are made 16 ft. long. Ordinary practice in formwork is followed for the front face, but the forms for the rear face of the front wall and the tie and rear walls are made as rough and cheap as possible without endangering the quality of concrete from leaky forms. The joints in the front wall, between adjoining cribs, are made plain, without any keys or dowels, so that unequal settlement of adjoining sections will not result in local injury.

Weep-holes are provided in the center of each cell and in the joints between cells. It was thought necessary to provide drainage in this manner, as the anticipated settlement of the wall would result in the destruction of any line of drain pipes placed behind it. With a 4-in. space between the property line and the face of the wall drainage can be provided in front if the leakage from the weep-holes proves objectionable.

About 1700 ft. of the cell-type wall will be built in connection with the track-elevation project. In general, the walls are being used in the embankment slope at some distance from the track. The greatest height of wall is about 14 ft., with the track elevated about 17 ft. above the original ground surface. In one case a wall 12 ft. 3 in. high is used, with the center line of track 8 ft. 6 in. from the front face of the wall.

The work is under the direction of Charles F. Loweth, Chief Engineer of the Chicago, Milwaukee & St. Paul Ry.

A Very Costly Road

The highway known as Hudson County Boulevard, which extends from Bayonne, N. J., along the westerly brow of Jersey City Heights to the northern part of Hudson County and thence to Weehawken and Hoboken, is entitled to the distinction of being one of the most expensive pieces of roadway in the United States. The total length of the road is 19 1/7 miles. There had been expended upon it to the end of 1914 the sum of $5,660,000, or about $290,000 per mile. This includes the cost of its construction, as shown by the county bonds which have been issued for construction and repair of the road since 1892, and the amount expended on maintenance, policing and lighting of the road since 1899.

The enormous expenditures on this road have already been subject to public investigation. A report upon it was made in 1912 by W. F. Whittemore, M. Am. Soc. C. E., to Hon. Francis J. Swayze, Justice of the New Jersey Supreme Court. An investigation was also made by the Hudson County Grand Jury in December last. The figures given below are taken from those given in these official investigations.

The road in question is a broad street, extending for most of the distance through a built-up section, and is paved with bituminous macadam. This paving appears to have been the main item of expense in the construction, comparatively little grading being required. The bonds that have been issued by the county for this road amount to $3,281,500. Of these, however, $860,000 was for repair purposes, it having been necessary practically to reconstruct the paving when automobile traffic over the road became heavy in the years following 1907.

In addition to this, $150,000 bonds for repairs on the road have just been issued, making a total of over a million dollars expended for repairs since 1908 on a road 19 1/7 miles long, on which there has been expended annually besides, from county funds, an average of about $170,000. The interest charges on the bonds issued for this road cost the county last year $143,800, or over $7000 per mile of road.

The expenditure on the road last year was $178,578.

Of this amount $117,000 was spent on salaries and wages, and of the balance, $16,000 was expended on the power house which furnishes current for lighting the boulevard, and $33,000 was expended on the road.

It is impossible to determine from the figures available what the actual cost of the roadway maintenance is, separate from the cost of its lighting, policing, etc. Mr. Whittemore computed that the total cost of the arc lamps on the road during the past five years has been about $122 per annum, or nearly $50 per year higher than the rate at which the lighting could be done by contract with the Public Service Co. The lighting plant was put into operation many years ago and is now obsolete and uneconomical.

Notwithstanding the great amount of money that has been expended on the Hudson County Boulevard, its surface is not maintained in good condition, and a large part of it will have to be rebuilt very soon to keep it safe for the heavy automobile traffic which is rapidly wearing it down.

News of the Engineering World

Inauguration of President of Johns Hopkins University

The new president of Johns Hopkins University, Dr. Frank J. Goodnow, formerly Professor of Administrative Law and Municipal Science at Columbia University, was inaugurated on May 20, in the presence of delegates representing many American colleges and universities. Honorary degrees were later conferred on a number of eminent men, among them Gen. George W. Goethals and Dr. Simon Flexner.

On the following day the two buildings recently completed for the university at its new location—the Academic Building and the Engineering Building—were dedicated, addresses being delivered by General Goethals and Dr. Henry C. Adams, who was for many years the Statistician of the Interstate Commerce Commission and was the first man to receive a degree from Johns Hopkins.

The new site for the university is in the suburb of Homewood in the northern part of Baltimore, and the tract purchased contains about 200 acres. Besides the buildings named, a power house has been erected from which all the university buildings will be lighted and heated. The present Engineering Building will later be used for the mechanical and electrical departments alone, as a separate structure is soon to be erected for the civil-engineering department.

Reserve Corps of Engineers for National Defense

At a fairly well-attended meeting of the American Society of Civil Engineers on May 19, a resolution, declaring that it was the sense of the meeting that the society confer with the Government for the purpose of placing the influence and facilities of the society at the disposal of the Government to assist in the organization of a reserve corps of engineers for possible service, either in construction of military works or in active service in the United States Army in times of necessity, was apparently unanimously, although by no means vociferously, adopted.

The resolution was proposed by Richard S. Buck, engineer of maintenance-of-way of the New York Railways Co., and followed a talk on the development of New York City, past and projected, by T. Kennard Thomson, and a brief description of some of the advances made in steam navigation by H. De B. Parsons.

Mr. Buck prefaced his resolution with a few remarks on the seriousness of the present situation of the National Government and enlarged upon the services the society could render the Government in case of necessity. Mr. Parsons and one or two others also spoke in favor of the resolution and of the weakness of our present standing army and national defenses. There appeared to be very little enthusiasm, even when the secretary assured the members that they could in no way commit the society, which through its Board of Direction had already appointed a committee to investigate such action, with William Barclay Parsons, of New York City, as chairman.

Drawspan to Be Moved

The new double-deck drawspan on the Second Ave. (New York City) bridge, which carries the Third Ave. elevated railway over the Harlem River, will be floated into place on Sunday, June 6. It is expected that work will start at 5 a.m. and replacement be completed by noon. The other two new spans of the bridge were moved into place on Feb. 22, as described in ENGINEERING NEWS of Feb. 25, p. 413.

The work will be done for the Interborough Rapid Transit Co. (under the direction of F. W. Gardiner, Principal Assistant Engineer) by the Terry & Tench Co.

New Formula for Concrete Slabs

A draft of a new ordinance to govern fireproof construction of buildings in New York City, prepared by a committee of the Board of Aldermen, with R. P. Miller as expert, contains the following rule for determining the safe carrying capacities of concrete-slab floors.

The gross load in pounds per square foot of floor surface shall not exceed the product of the depth in inches of the reinforcement below the top of the slab, by the cross-sectional area in square inches per foot of width of the tensional steel, divided by the square of the span in feet, all multiplied by the following coefficients: When cinder concrete is used 14,000 if the reinforcement is not continuous over the support, 18,000 if the reinforcement consists of rods or other shapes securely hooked over or attached to the supports, and 26,000 if the reinforcement consists of steel fabric continuous over the supports; and when stone concrete is used, 30,000 and 40,000 respectively.

The draft is open to public discussion until June 2 and later will be presented to the Board of Aldermen for passage. This is part of the section-by-section revision of the city's building code, now in progress.

Asphalt Pavement Slides Off Bascule Bridge

A bascule bridge 147 ft. long and 66 ft. wide was recently erected jointly by the Southern Pacific and Atchison, Topeka & Santa Fé railways to carry their double line of tracks over the channel of Islais Creek, in the southeastern suburbs of San Francisco.

As a precaution against fire it was decided to pave the bridge with an asphalt surface on a wooden base, with a

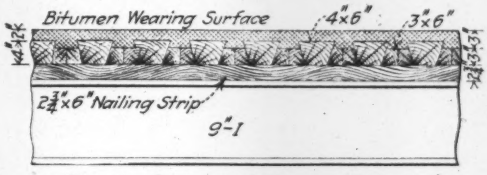


FIG. 1. DETAIL OF BRIDGE FLOOR

detail as shown in Fig. 1. It was thought that the keyed wooden flooring would be sufficient to hold the asphalt surface rigid when the drawbridge was in a vertical position. Such did not prove to be the case, for when, on May 8, 1915, the bridge was up-ended the adhesion between the asphalt and the concrete did not prove sufficient

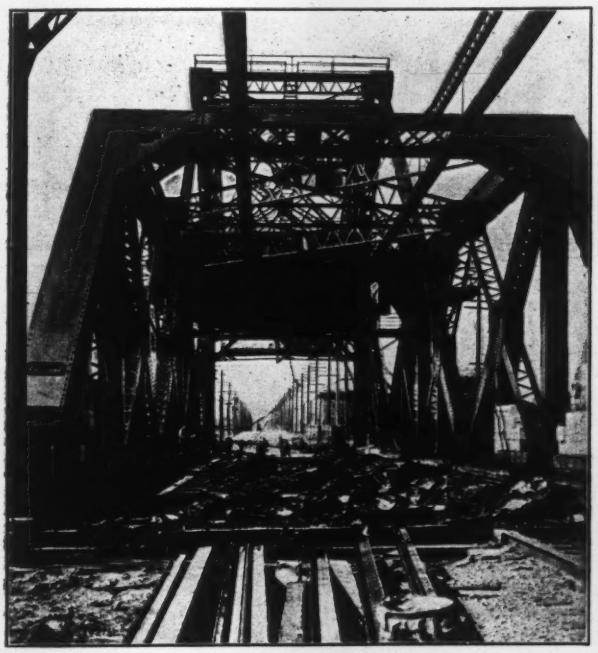


FIG. 2. ASPHALT BRIDGE FLOOR AFTER LOWERING OF BASCULE

to hold the surface in place. Numerous cracks developed during the first five minutes, and after the bridge had been held nearly vertical for 20 min., the pavement parted in several places and slid downward. It was therefore decided to abandon this type of pavement on the bridge and to substitute creosoted-fir flooring.

Philadelphia Sewage Report

Three sewage-treatment works for Philadelphia, which in 1950 would probably treat 707,000,000 gal. of sewage from a population of 3,153,000, are recommended in a "Report on the Collection and Treatment of the Sewage of the City of Philadelphia," just made public.* These works, together with collecting and intercepting sewers and pumping stations, are estimated to cost $34,600,000, but only $22,400,000 is needed to provide for the collection and treatment of all the present and immediate future dry-weather sewage and "first flush of rainfall." The $22,400,000 would be distributed over a period of about five years, in accordance with the program given below. Broadly speaking, the report recommends the utilization of the Delaware River for the dilution and oxidation of sewage freed from suspended matter by coarse screens, grit chambers and two-story sedimentation tanks of the Emscher or Imhoff type. For the smallest of the three works, fine screens would be used instead of settling tanks—at least for a time. If necessary, percolating filters or other oxidizing works would be added in the future.

All three of the proposed works would be located on the Delaware River, as follows: (1) *Northeast Works,* for the northern part of the city, located south of Bridesburg; to consist of coarse screens, grit chambers and Imhoff tanks. (2) *Southeast Works,* for the southeastern part of the city, located in the vicinity of Greenwich Point; to consist of coarse screens, grit chambers and fine screens. (3) *Southwest Works,* for the central and western parts of the city, to be located in the southern part of West Philadelphia, near the junction of the Schuylkill and Delaware rivers; to consist, like the Northeast Works, of coarse screens, grit chambers and sedimentation tanks.

It is recommended that $5,000,000 be appropriated at once. Of this, $1,700,000 would go for sites for the three sewage-works. The remainder, in two successive installments, would be spent for sufficient units of the Northeast Works, with collectors and accessories, to treat the 70,000,000 gal. of sewage daily from a population of 300,000.

These sections of treatment works and collectors would maintain Frankford and Pennypack creeks in a clean condition, prevent the discharge of crude sewage into the Delaware River between Bridesburg and the northern boundary of the city, and maintain the water of the Delaware River as a fit source of water-supply.

Next in order would come $5,700,000 and then $4,800,000 to restore the Schuylkill River to a clean condition by collecting sewage and treating it at the Southwest Works. After this, $3,400,000 would be spent for extending the Northeast Works and collecting system. All this done, $3,500,000 would be used for the Southeast Works and collectors and for enlarging the two treatment works previously built. These expenditures would comprise the $22,400,000 already mentioned as advised for the immediate future. They would divert from the creeks and rivers and treat to a greater or less extent all the dry-weather flow of sewage and the first part of the storm flow. The operation and maintenance of the works so provided would cost about $500,000 a year.

The collecting sewers included in the foregoing estimates would be sufficient until 1950, but the "greater de-

*The report was made for the Department of Public Works of Philadelphia by George S. Webster, Chief Engineer of the Bureau of Surveys; George E. Datesman, Principal Assistant Engineer, and W. L. Stevenson, Assistant Engineer. Besides extensive studies of river conditions and of the many local engineering factors which govern the economic design of collecting and intercepting sewers, pumping stations and treatment works, the conclusions of the report are based on the operations of a sewage-testing station at Philadelphia in 1909 and 1910 (see "Engineering News," Apr. 27, 1911, pp. 505-7 and 513) and upon studies of European sewage-works made by Mr. Webster in 1908 and by Mr. Datesman in 1913.

gree of refinement" of sewage treatment required before that time would call for an outlay of $12,200,000, making a total outlay of $34,600,000 up to 1950.

The report recommends coöperation between Pennsylvania and New Jersey, "so as to secure concordant action for the treatment of the sewage of communities in these states which is discharged into the Delaware River or its tributaries."

In view of the stand for separate sewers throughout the state which, it is understood, has been made by the Pennsylvania Department of Health, it is notable that the Philadelphia engineers advise against changing from the combined to the separate system at Philadelphia. Another notable feature of this report is its inclusion of estimates of large savings effected by changes in grades, the adoption of siphons and the elimination of pumping stations as a result of careful studies of European practice and local conditions.

Repair Work on the Dallas-Oak Cliff Viaduct

Repairs are practically completed on the Dallas-Oak Cliff reinforced-concrete viaduct at Dallas, Tex., where during December last* the expansion of a wood-block pavement forced out of line, and in some places fractured, the bracketed sidewalk.

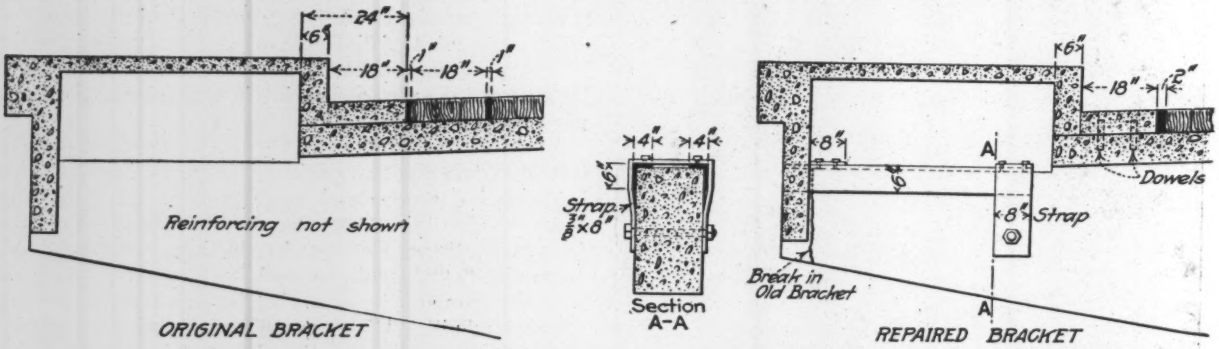
The method of repairing the damage is shown in the accompanying drawings, which, it should be noted, differ in one detail from the section of the sidewalk given in the previous description of the failure. The former drawing showed the gutter as a separately laid block resting on the floor slab and against the curb. In reality the curb and gutter-shoulder were poured at one time, leaving a horizontal break between gutter and floor slab, as shown in the accompanying drawings. In expanding, the wood-block floor pushed this curb outward, fracturing some of the cantilever beams.

There were in the original design four 1-in. expansion joints, one along each gutter and one about 18 in. from each gutter. In the repair work additional expansion joints were provided by removing a 2-in. strip of the wood blocks along each gutter for the length of the viaduct and filling the openings with a soft asphaltic cement.

Where the walk had been merely pushed out of line, which occurred in about sixteen of the 44-ft. spans, the concrete gutter blocks were removed and the curb and walk pulled back into line. Then 1-in. iron dowels were cemented into the floor slab and left to extend high enough so that they reached into the new gutter block which was poured later. The surfaces of the slab and curb were roughened to increase the bond.

Those cantilever brackets which had been cracked through about along the line shown in the right-hand section were strengthened by braces made up of pairs of 4x6x⅜-in. angles extending along the upper edges of the beam from under the fascia girder nearly to the curb. At the inside end these angles were held together by a ⅜x8-in. plate bent over the beam and anchored thereto by a through-bolt. At the outside end the concrete in the fascia girder was dug away to permit extending the angle-irons clear to the face of the girder and the angles then grouted into the opening thus made. In some of the broken beams it was found that the upper tension rods did not extend to the fascia girders. The latter were patched up in places by grouting, and where total failure occurred, for a distance of 44 ft., new fascia girders, curb and gutter, sidewalk and railing were built.

The first bids for the repair work were rejected Jan. 21 last and new bids invited, without any response. The work was then completed by day labor under the direction of J. F. Witt, County Engineer. The estimated cost is $3000.



Old and Repaired Brackets on Dallas-Oak Cliff Viaduct

A Rock-Tunneling Machine for Chicago

An important step in tunneling methods is the decision to use a rock-tunneling machine in the Wilson Ave. lake intake tunnel at Chicago, although the machine in this case will drive only a small pioneer hole, 12 in. diameter. The tunnel is now under construction by the city (by day labor) and was described in our issue of Apr. 22. The J. P. Karns Tunneling Machine Co., of Cleveland, Ohio, has closed a contract with the Department of Public Works for the installation of one of its heading machines, and the contract is of interest from the fact that the company will receive as its pay 33% of the saving in cost of drilling and explosives as compared with the cost of the work as ordinarily done.

The tunnel is in solid rock and is of horseshoe section 12 ft. 3 in. by 13 ft. and 11 ft. 4 in. by 12 ft. The tunneling machine will drive a 12-in. central heading, or hole, which is expected to take the place of the ordinary cut holes and give the necessary release for the helper and

* "Engineering News," Jan. 14, 1915, p. 92.

trim holes, thus enabling the work to progress much more rapidly and with less consumption of explosive. The Karns machine (described in ENGINEERING NEWS, Mar. 5, 1913) was designed originally to drive a 6-ft. heading, which would be enlarged to full tunnel section. The machine as adapted to the Chicago work will be much simpler and lighter. It operates on the same principle, having a single reciprocating head (12 in. diameter instead of 6 ft.), fitted with cutting blades and striking the rock a series of rapid blows. The head revolves slightly at each stroke.

The machine will be in operation probably within about two months. John Ericson is City Engineer, and Henry W. Clausen is Engineer of Water-Works Construction in the Department of Public Works, in charge of the tunnel work.

ENGINEERING SCHOOLS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY—The hydraulic laboratory which will be provided in the new buildings in Cambridge is expected to excel any other of the kind in this country. It will occupy about one-third of a space about 55x300 ft. and will be four stories high. It will be equipped with every sort of hydraulic apparatus, including all kinds of pumps, a pressure tank permitting heads up to about 600 ft. for experiments on nozzles and orifices, weirs of all kinds and sizes, several tangential waterwheels, an inclosed-turbine and a large open-turbine testing plant, where heads up to 35 ft. will be made available by a 30-in. steam-driven centrifugal pump. Water will be taken from the Charles River into canals in the basement of the building, where it can be stored or circulated.

NEWS NOTES

A Fire in a Railway Tunnel near Cable, Calif., which started early on the morning of May 14, stopped Southern Pacific and Santa Fé trains at this point. Both ends of the tunnel, which is about 361 ft. in length, and timbered, were blocked in an endeavor to smother the fire.

Severe Railway Wreck in England—Three trains collided on the Caledonia Ry., at Gretna, England, at 6 a.m. on May 23, resulting in the death of 156 persons and the injury of 300. One of the trains was carrying 500 troops and this train collided with a local from Carlisle. Before the resulting confusion had subsided an express from London bound for Glasgow crashed into the wreck. The wreckage caught fire. Most of the killed and wounded were soldiers.

High Water Damaged a Bridge over the Red River at Shreveport, La., on May 9. Previously, a 24-ft. span on the extreme east end had collapsed, and this had been recovered on May 8. In the second collapse it was swept away with a 100-ft. span. Some falsework and a derrick car used in an effort to save the bridge were also lost. The cylinder pier on the east end of the drawspan was deflected westward about 1 ft.; the drawspan was uninjured. When the damage occurred the Red River was at about flood stage.

Jitney Busses recently unceremoniously quit the city of Pueblo, Colo. According to the "Pueblo Chieftan," their drivers failed to appear on a few rainy days and their fair-weather patrons thereafter refused to use them when they did reappear.

All Telephone Companies in Illinois after July 1 will be under the jurisdiction of the State Railroad and Warehouse Commission as the result of the recent Minette Bill of the state legislature. No policy in regard to the regulation of telephone companies has yet been formulated by the commission, but it is expected that a telephone expert and staff will be taken on.

Prizes for Essays on Economic Subjects for the year 1916, offered by Hart, Schaffner & Marx, of Chicago, are again announced. Among the suggested subjects of the essays are: A Critical Study of the Appropriations for Rivers and Harbors in the United States, 1895-1915, and the Needs and Future of American Shipping. The prizes offered amount to $2000. The chairman of the committee intrusted with the examination of the essays and the award of the prizes is Prof. J. Lawrence Laughlin, of the University of Chicago.

The Copper Production of the United States in 1914 was 766,890 tons of new metal and 15,963 tons of recovered scrap, according to advance statements of the U. S. Geological Survey. The concerns treating scrap produced an additional 112,000 tons of copper in brass and other alloys. About 4300 tons of copper was put out in bluestone (copper sulphate) by the refining companies. The total production of primary and secondary copper was 43,291 tons below the 1913 figure. There was an increase of 41,628 tons in the reported stocks of copper-producing companies.

New York State Town Awarded State Highway Contract—The town of Southampton, on Long Island, has been awarded the contract for the construction of 10½ mi. of state-aid highway between Quogue and Southampton. The town's bid was $113,068 against bids from 16 contractors ranging from $114,209 to $152,582. The contract is upon the same terms under which a contractor would work, and theoretically, at least, the town will be held by the State Highway Department to as strict an accountability. Similar contracts have been let before, but are reported to have been unsuccessful in their purpose of saving the public money.

Culebra Cut on the Panama Canal has been renamed Gaillard Cut by order of President Wilson, in honor of the late Lieut.-Col. D. D. Gaillard, Corps of Engineers, United States Army. The President in his order says: "As a member of the Isthmian Canal Commission from Mar. 16, 1907, to Dec. 5, 1913, Lieut.-Col. Gaillard was in charge of the work in Culebra Cut until its virtual completion, being compelled to abandon his duties in July, 1913, through an illness which culminated in his death on Dec. 5, 1913. His period of Panama Canal Service included the years of most active construction work. He brought to the service trained ability of the highest class, untiring zeal and unswerving devotion to duty. I deem it a fitting recognition of Lieutenant-Colonel Gaillard's service to the country to rename in his honor the scene of his life's triumph."

The Marginal Freight Railway of the City of New York was authorized by the Cullen bill, signed by Governor Whitman on May 24. This clears the way for work on a project which has been agitated for several years (see "Engineering News," Mar. 7, 1912, p. 421, and May 22, 1913, p. 1098). The new line will probably extend south along the Brooklyn waterfront from Brooklyn Bridge to about 66th St., and will give freight exchange for districts now unconnected. The railway facilites of the New York Dock Co. and the Bush Terminal Co. will probably be taken over and incorporated. The rails will be at surface except where elevated to avoid grade crossings. There is planned to be a large classification yard with car-ferry bridges and a line to the New York Connecting Ry. This railway would be built and owned by the city, but it would be leased for operation to a corporation formed by all the trunk lines reaching the port of New York.

Bond and Charter-Amendment Election at Denver—At an election on May 18 the people voted on five bond issues and on two charter amendments. The bond issues, which were for municipal buildings aggregating a million in cost, were defeated by a vote of about three to one. A proposition to abolish the Public Utilities Commission, created some years ago to secure municipally owned water-works, was defeated by a vote of 9349 for to 19,465 against. The second charter-amendment proposition, which was to abolish the Moffat Tunnel Commission, was carried by a vote of 17,447 for to 10,069 against. This commission was created to build a tunnel through the Continental Divide to be used by the city for conveying water and electric current and by the Denver & Salt Lake R.R. Bonds were voted for the purpose. The State Supreme Court declared that the project was an attmept to evade the constitutional prohibition against the use of city funds for the benefit of private corporations. (See "Engineering News," Mar. 5, 1914, p. 541, July 2, 1914, p. 31, and July 16, 1914, p. 156.)

A Census of Automobiles in the United States has been made by the Office of Public Roads by collecting the motor-vehicle registration records of the various states for the year 1914. These records show the total number of vehicles registered in the United States as follows: Automobiles, 1,-

666,984; motor trucks, 44,355; motorcycles, 152,945. New York leads in the number of automobiles, the total being 150,898. Then come in the order named, Illinois, California, Ohio, Pennsylvania and Iowa. In each of these states over 100,000 automobiles were registered in 1914. It will be noted that a large use of automobiles in the agricultural states is indicated by the above figures and also by the figures for some other agricultural states as follows: Indiana, 66,500; Kansas, 49,374; Michigan, 76,389; Minnesota, 67,862; Missouri, 54,468; Texas, 40,000; Washington, 30,253; Wisconsin, 53,161. The use of motor trucks appears to be pretty closely confined to the states with a large mileage of improved roads. New York leads again with 17,325; Massachusetts has 8326; Pennsylvania 6453 and Connecticut 2968. The gross revenues from automobile registration fees in 1914 were $12,270,000, besides which state-road funds benefited by automobile fines amounting to over $100,000.

Wind Movements during Colon Fire—The $3,000,000 conflagration at Colon, C. Z., on Apr. 30, afforded interesting records of the local wind generated by a great fire. The "Canal Record" for May 5 comments on this. The hydrographic station at Colon is situated on the old Panama R.R. office building, several hundred yards from the fire, and the Section of Hydrography and Meteorology states that the peculiar variation of the wind in the afternoon of Apr. 30, during the progress of the fire, was due in large part to the fire. The heated air, rising, set up local currents recorded as wind. The rates and directions of movement in the period from noon to midnight were as follows:

Hour	Mi. per hr.	Hour	Mi. per hr.
12 to 1	7 NW	6 to 7	13 N
1 to 2	7 NW	7 to 8	12 N
2 to 3	9 NW	8 to 9	12 N
3 to 4	10 N	9 to 10	9 NE
4 to 5	15 N	10 to 11	5 NE
5 to 6	15 N	11 to 12	3 NE

The maximum rate was 17 mi., from the north, at 4:40 p.m. The fire was in progress from about 3 to 9 p.m., and burning strongest between 4 and 6. The change of direction of the wind is also regarded as showing the influence of the fire.

Plans for the New Interior Department Building at Washington have been completed and bids for its construction are to be opened on July 13. The building is to provide accommodations for the Geological Survey, the Reclamation Service, the Bureau of Mines, the General Land Office, and the Bureau of Indian Affairs, which have been hitherto housed in six separate rented buildings, none of them fireproof. The building will be located on the block bounded by F and G St., and 18th and 19th St. The principal front, facing on F St., will be 402 ft. long. The plan of the building forms a capital E, the three wings extending from F St. back toward G St., a distance of 392 ft. The building will be six stories in height, and the courts between the wings will be 119 ft. in width, thus affording an abundance of light and air. The architectural design of the building resembles that of the new Bureau of Engraving and Printing rather than the older type of Government buildings, which, while architectural monuments, were generally poorly lighted. A notable innovation in the arrangement of the offices is that instead of having all the offices of a bureau on the same floor, each bureau will have a section of the building and will occupy several floors, with elevator service provided for each section. With buildings covering such a very large area as this it is believed that this grouping will facilitate intercommunication and economize time. The estimated cost of the building is $2,500,000, and it is to be completed early in 1917.

PERSONALS

Mr. W. S. Hanley, Assoc. M. Am. Soc. C. E., Chief Engineer of the New Orleans Great Northern R.R., has been made Superintendent of the road; with headquarters at Bogalusa, La.

Mr. Ralph S. Torrance, formerly Electrical Engineer of Kohler Brothers, of Chicago, has opened an office at 111 West Monroe St., in that city, as a consulting electrical and mechanical engineer.

Mr. A. L. Moler has been made Senior Inspector of Motive Power of the Eastern District of the Division of Valuation of the Interstate Commerce Commission. His headquarters will be in Washington, D. C.

Mr. Daniel S. Hooker, who was formerly in the service of the Colorado & Southern Ry., as Locating and Construction Engineer, has been appointed Civil Engineer of the Public Utilities Commission of Colorado.

Prof. John Clayton Tracy, Assistant Professor of Structural Engineering, has been elected Professor of Structural Engineering of the Sheffield Scientific School and a member of its Governing Board, by the Yale Corporation.

Mr. Charles Saville, Assoc. M. Am. Soc. C. E., of the firm of Bartlett & Ranney, Inc., Consulting Engineers, of San Antonio and Dallas, Tex., has been appointed Director of Sanitation of the newly reorganized Department of Health of the City of Dallas.

Maj.-Gen. George W. Goethals, M. Am. Soc. C. E., had the degrees of Doctor of Laws conferred on him by Johns Hopkins University, Baltimore, Md., at the inauguration, on May 20, of Dr. Frank Johnson Goodnow as the third President of the University.

Mr. Charles R. Pratt, M. Am. Soc. M. E., has opened an office at 55 Liberty St., New York City, as a consulting engineer. He will give particular attention to the system which he has recently devised for the conversion of hydraulic elevators to electric operation.

Mr. J. X. Cohen, Jun., Am. Soc. C. E., who for the past eight years has been associated with Dr. Rudolph Hering, first with the firm of Hering & Fuller and later with Hering & Gregory, of New York City, has resigned, in order to accept an appointment as Designing Engineer of the Syracuse Intercepting Sewer Board, for the projected sewage-disposal works of Syracuse, N. Y.

Mr. George B. Holbrook, of Springfield, Mass., has been elected President of the Connecticut River R.R., to succeed Mr. John H. Alvin, of Concord, N. H. Previous to his retirement from active business two years ago, Mr. Holbrook was Treasurer of the American Writing Paper Co., of Holyoke, and head of the Beebe-Holbrook Paper Co., of Holyoke, of which concern he was the founder.

Mr. Preston K. Yates, M. Am. Soc. C. E., Consulting Engineer, New York City, has taken his son, Sheldon F. Yates, into partnership under the firm name of Yates & Yates. Mr. Sheldon F. Yates was for two years an instructor in the Harvard Engineering School under Professor Swain. He has since then been Principal Assistant Engineer on the construction of the New Haven Trap Rock Co.'s plant at North Branford, Conn., which was described in "Engineering News" of Mar. 25, 1915. The offices of the firm are in the new Equitable Building, 120 Broadway.

OBITUARY

Edward Harding Barnes, Chief Engineer of the Grand Rapids & Indiana Ry., died at his home in Grand Rapids, Mich., on May 15. He was formerly in the service of the Pennsylvania R.R.

Arthur M. Greene, formerly a prominent contractor of Philadelphia, died at the home of his son, Prof. Arthur M. Greene, Jr., of the Faculty of Rensselaer Polytechnic Institute, Troy, N. Y., on May 19, in his 77th year.

Samuel D. Lehr, for 30 years City Engineer of Allentown, Penn., died in that city on May 18 after a four months' illness with apoplexy. Colonel Lehr also served as Mayor of Allentown, and when the city adopted the commission form of government he was placed at the head of the highway department. A widow and a daughter survive him.

Edmond Coignet, head of the famous firm of reinforced-concrete specialists, Edmond Coignet et Cie., died in Paris on Mar. 29 after a long illness. Mr. Coignet was the son of Francois Coignet, who as early as 1861 suggested the structural possibilities of concrete-encased metal. The son graduated in engineering from the "Ecole Centrale" in Paris and later took up the studies started by his father, early perfecting a system which, through a very complete international organization, has had wide use. Of late years he has devoted his time to general contracting and banking, in addition to heading the firm which bore his name.

Walter C. E. Moberly, a prominent Canadian engineer who did much pioneer work in opening up British Columbia, died at Vancouver, B. C., on May 14, at the age of 83. He was born at Oxford, England, and came to Canada when quite young. After studying his profession in Toronto, he was engaged for some time in railway and exploration work and went to British Columbia in 1858, where he was appointed Superintendent of Public Works. Subsequently, he was engaged in the construction of the Yale-Cariboo wagon road.

He became Surveyor-General in 1864 and made important explorations in the south and southeast of the province, during which he discovered the Eagle Pass in the mountains, which fixed the route for the Canadian Pacific Ry. After some years spent in the Western States, Mr. Moberly was in 1871 appointed by the Canadian Government as engineer to take charge of the surveys for the Canadian Pacific west of the Eagle Pass. Removing to Manitoba, he promoted the construction of the Manitoba Southwestern Ry., of which he became Chief Engineer. He built the first system of sewers in Winnipeg and constructed the tramway at Grand Rapids on the Saskatchewan River, for the Hudson Bay Co. He was the author of a work on "The Rocks and Rivers of British Columbia" and other publications.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN SUPPLY AND MACHINERY MANUFACTURERS' ASSOCIATION.
June 3-4. Annual convention at Bellevue-Stratford, Philadelphia, Penn. Secy., F. D. Mitchell, 1510 Woolworth Bldg., New York City.

NATIONAL CONFERENCE ON CITY PLANNING.
June 7-9. National Conference in Detroit, Mich. Secy., Flavel Shurtleff, 19 Congress St., Boston, Mass.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 9-11. Annual convention in Atlantic City. Secy., Jos. M. Taylor, Karpen Bldg., Chicago.

MASTER CAR BUILDERS' ASSOCIATION.
June 14-16. Annual convention in Atlantic City. Secy., Jos. M. Taylor, Karpen Bldg., Chicago.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 22-25. Annual meeting at Iowa State College, Ames, Iowa. Secy., F. L. Bishop, University of Pittsburgh, Pittsburgh, Penn.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
June 22-25. Summer meeting at Buffalo, N. Y. Secy., Calvin W. Rice, 29 W. 39th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 22-26. Annual meeting in Atlantic City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

Southwestern Water Works Association—The Fourth Annual Convention will be held in Galveston, Tex., June 14-16. Among the papers scheduled for presentation are the following: "Making a Municipal Plant Pay," R. S. Naylor; "Leakage from Cast-Iron Water Mains," James W. Ivy; "When is a Meter a Meter and When not a Meter?", A. M. Burgess; "Marshall Water Works, 15 Years' Growth," Ben F. Meyers; "The Filtered Water-Supply of the Canal Zone," Guy Eldredge; "The Trials of the Water Commissioner in a Small Town," L. H. Gray. The Secretary is E. L. Fulkerson, Waco, Tex.

Association of Iron and Steel Electrical Engineers—The next monthly meeting in Pittsburgh will be held Saturday, June 5, at the German Club, and will be in the nature of a smoker. There will be a general discussion on miscellaneous matters of general interest to the Association, but the principal interest of the evening will probably be centered in the entertainment features. The annual meeting will be held Sept. 8-11, at Detroit, Mich., at the Hotel Statler. The Secretary is W. T. Snyder. The Chairman of the Convention Committee is A. H. Swartz, Churchill Ave., Cleveland, Ohio.

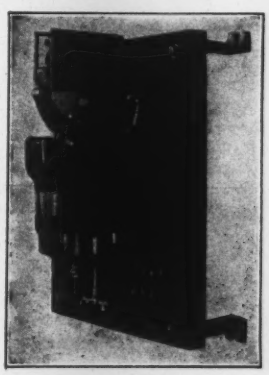
International Railway Fuel Association—The Seventh annual meeting was held at the LaSalle Hotel, Chicago, May 17-20. In connection with it there was an extensive exhibit of coaling-station equipment and apparatus for handling coal. A paper on "Powdered Coal," by W. L. Robinson (B. & O. R.R.), reviewed the possible advantages of this fuel for locomotives, but said little about actual practice or experience. Mr. Stroud (of E. H. Stroud & Co., Chicago) and Mr. Harrington (of the Powdered Coal Engineering & Equipment Co., Chicago) spoke in favor of the system. The latter suggested that the introduction of pulverized coal for locomotives might result in checking the public demand for railway electrification in cities, since it would eliminate smoke, sparks and cinders and permit of muffling the exhaust. The cost of equipping a locomotive for burning pulverized coal he estimated at $4500. Mr. Bentley (C. & N. W. Ry.) pointed out a number of difficulties and problems to be solved, and other representatives of railway mechanical departments discounted the favorable aspects presented in the paper. A paper on "Fuel Oil for Locomotives," by G. M. Bean (American Arch Co.), suggested further experiment with superheated steam for the burners. The report of the Committee on Mechanical Stokers stated that about 935 locomotives thus equipped are now in service, and that in most cases they can use cheaper grades of coal than can be used with hand firing. In a paper on "Smoke Prevention," E. W. Pratt (C. & N. W. Ry.) reviewed the methods adopted at Chicago by the railways and the city authorities to abate the smoke nuisance. Practically all locomotives operating in the city are equipped with special apparatus, and it has been shown that in this way engines can burn soft coal with very little smoke if the engine crew takes proper care. The city has a smoke inspection bureau and the railways have about 54 smoke inspectors. The latter act jointly for all the roads, thus eliminating discrimination. The average density of railway smoke has been reduced from 10.74% in 1912 to about 7% in 1914. The storage and weighing of coal at railway coal-storage plants and coaling stations was reviewed in the report of the Committee on Coaling Stations, presented by H. J. Slifer. This report gave a number of plans of coal-handling plants and called attention especially to the necessity of accurate weighing or measuring of the coal going into and coming out of the plant. It described also the great coal-handling and storage plants of the Panama Canal. D. C. Buell, Union Pacific Ry., Omaha, was elected President.

Appliances and Materials

Automatic Reclosing Circuit-Breaker

A radical departure in electric circuit-breakers is being marketed by the Automatic Reclosing Circuit Breaker Co., of Columbus, Ohio. The new devices not only open the circuit in case of overload but automatically restore connections to the mains as soon as the overload or short circuit is removed. Moreover, they can be adjusted to reclose on any desired load resistance, so that they distinguish between a short circuit and the resistance of lamps or self-starting motors remaining connected.

The operation is shown by the accompanying sketch. The main contact is held closed by the closing coil, the plunger of which engages an arm pivoted at one end and carrying at the other a roller which moves on the main contact arm. The closing coil is connected across the main line between Points 1 and 2. At first it secures full potential, but soon the resistance R_1 is cut into circuit and thereafter only a few watts are drawn. If a short circuit should occur, as at the load, the excess current through the series coil would draw its core up, throwing the bell-crank above, opening the circuit of the closing coil and causing the main contacts to open. The bell-crank L is locked open by the latch H.



300-Amp. Reclosing Breaker

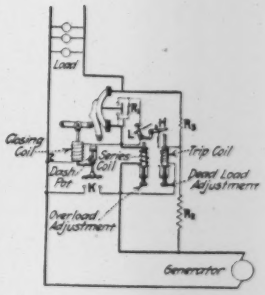


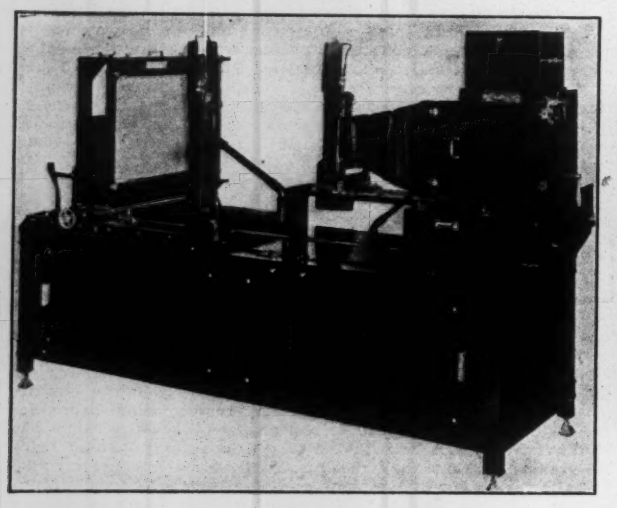
Diagram of Reclosing Breaker

After opening the main contacts a small index current flows around the gap through the resistance R_2 and R_3 and the dashpot plunger descends to bridge the trip-coil contacts at K. After this the index current flows through both the trip coil and the low resistance R_3 in series with the short circuit. When the short circuit is removed, so that the load resistance rises to the allowed value, enough current will flow through the trip coil to make it release the latch H and let the bell-crank L close the operating-coil circuit to reset the circuit-breaker.

The main contacts are of the usual laminated-brush construction, with auxiliary carbon tips. The air dashpot can be adjusted for various lengths of time before the breaker recloses. The new apparatus is entirely automatic and may be located at any convenient point in the distribution system.

Machine for Double Paper Photographs

The machine shown in the accompanying view, styled the "Duplex Cameragraph," has been developed by the Cameragraph Co., of Kansas City, Mo., for making photo-copies of book pages, documents, etc., on both sides of sensitized paper. A single lens is used to photograph two objects or opposite sides of one object on opposite sides of the same sheet. The advantages of this process are a 25% saving on cost of prints



DUPLEX PHOTO-REPRODUCER

and a 50% reduction in bulk of bound or stored prints. As far as possible, parts of the machine, like the interchangeable paper boxes, measuring devices, rewinds, are identical with those on the company's "Simplex" photo-reproducer (which prints on one side only). Metal construction is used throughout except for the bellows. The machines are leased for 99 years (at prices ranging upward from $500 for the "Simplex").

* * *

Pintsch Gas Widely Available

During the many years in which Pintsch oil gas has been largely used for lighting steam-railway cars, the compressed gas supplied to the railroads has not been available for general distribution. The policy of the Safety Car Heating & Lighting Co., controlling the industry in this country, now seems to have changed, for the Pintsch Compressing Co., of New York City, allied with the Safety company, is now supplying gas for isolated lighting and heating installations.

A somewhat different gas from the railway supply is now being made for this business; about 20 lb. of the original gas could be stored in a 6-ft. flask under a pressure of 150 at-

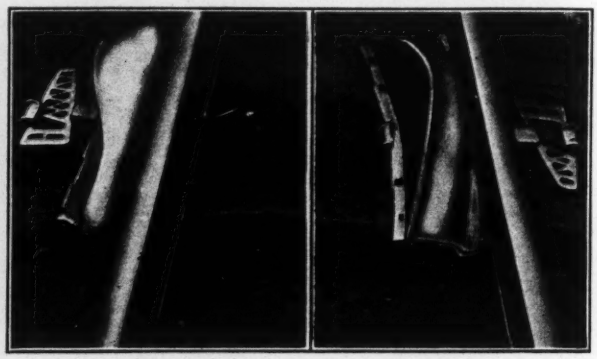
PINTSCH ISOLATED GAS-LIGHTING OUTFIT

mospheres, whereas 16 lb. of the new gas, called "Isolite," can be stored in a 38-in. cylinder under the same pressure. Gas is shipped from the company's nearest compressing station to the customer in steel flasks, much as any of the several compressed gases are now supplied for industrial service. The flask is not kept by the consumer, but the gas is allowed to pass into a larger receiving tank, where it is stored at a pressure of four or five atmospheres. A pressure-reducing regulator is interposed between the house line and the storage tank. The gas has a thermal value of about 1400 B.t.u. per cu.ft. On account of this, special fixtures have to be employed. The storage and regulating equipment is leased to the consumer at 50c. per month. The gas is sold for 10c. per lb., the company paying return freight on empty flasks. The gas has a volume of about 15 ft. per lb., which, together with the calorific value, makes an equivalent service about equal to $3 town gas.

* * *

Cast-Steel Rerailers

The frogs, shown herewith, for replacing derailed cars and engines on the rails are steel castings. The outside rerailer is so made as not to foul the column bolts of a derailed truck and so keep it from sliding up to the rail. It has a broad outside flange, and its inner flange rests upon the rail base while lugs on the side fit under the rail head, so that the rail and frog cannot tilt away from each other under the lateral forces exerted during the movement of the derailed truck.



CAST-STEEL RERAILING FROGS

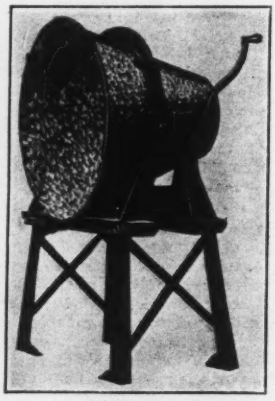
The inside rerailer has similar lugs, which fit under the rail head and are of such length as to keep a flangeway open between the rail head and the face of the rerailer. The wheels are engaged by the treads alone until high enough to clear the rail, being then crowded over.

Instead of relying entirely upon a number of spikes (which are hard to drive under a derailed car or engine) each rerailer is secured by a clamp. One end of this is hooked over the rail base, and the other secured by a loose lug and taper key. These rerailers are made by the Reading Specialties Co., of Reading, Penn.

* * *

Small Hand Concrete Mixer

The Giesler portable concrete mixer for small jobs, shown in the accompanying view, has a conical galvanized-iron revolving drum of 2-cu.ft. capacity, fitted with interior blades. Fastened around the drum is an iron ring which rests on a pair of idler rollers. The rear face of the ring is a bevel gear meshing with a pinion on the short shaft carried by one standard. This shaft may be fitted with a crank handle or a pair of tight-and-loose belt pulleys.



GIESLER HAND CONCRETE MIXER

With the drum in the position shown, the door at the top is removed, and a charging hopper is inserted. After the drum is charged, the door is replaced and fastened. When the proper number of revolutions has been made the drum is stopped with the door at the bottom. Then as the door is removed the concrete flows into the wheelbarrow or spout. The machine weighs less than 200 lb. and may be mounted on a truck or a fixed frame. It is built by the Galland-Henning Manufacturing Co., Milwaukee, Wis.

* * *

Air-Tight Canvas Tubing

Under the trade name "Flexoid," heavy coated canvas tubing is being put out by the Bemis Bros. Bag Co., of St. Louis, for carrying air into tunnels and shafts or taking off fumes, etc. It is put up in 10- to 24-in. diameters and 100- to 500-ft. sections; a man can carry 100-ft. on his shoulder. The canvas from which these tubes are made appears to be rendered air-tight and waterproof by a rubber coating applied to one side and forced partly through the fabric.